OPTIMATION, INC.

BC 328800

INSTRUCTION MANUAL

MODEL AC-101, 101A

LABORATORY AC SOURCE

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PRECISION AC INSTRUMENTS

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MODEL AC-101, 101A

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Section I

GENERAL INFORMATION

1.1 SCOPE

This publication is the basic handbook of instructions for operation, service, and maintenance of all versions of the Optimation Model AC-101 Laboratory Power Source. It presents a detailed description of the unit as follows:

1. General Description and Specifications.
2. Installation information.
3. Operating instructions.
4. Principles of operation.
5. Maintenance.
6. Table of replaceable parts.

1.2 APPLICATIONS

The AC-101 Power Source (Figure 1-1) is intended for use in laboratory applications where requirements exist for a very stable source of high purity power in the audio frequency range over a wide range of voltages and currents. The AC-101 is capable of providing either constant current or constant voltage output selectable from the front panel. The performance characteristics of the unit are virtually unaffected by reactive or non-linear loads.

With its very high amplitude stability and ultra low distortion characteristics the AC-101 is ideally suited for use as an AC source for meter and instrument calibration in conjunction with thermal transfer standards or other precise AC measuring devices. The AC-101 is also ideal for applications that require an AC source of high stability and high purity in the frequency range from 10 to 100,000 cps.

1.3 DESCRIPTION

The basic AC-101 Power Source consists of a Model RCD-4A Precision Oscillator, a Model PA-250D 250-watt Amplifier, a Model T-100R Transformer, and a line Power Control panel mounted in a decorative cabinet.

Optionally available is a Ratio Transformer control panel inserted between the oscillator and amplifier to provide precise voltage output steps after the AC-101's output has been standardized with a device such as an AC thermal transfer standard.

1.3.1 Electrical Description

The AC-101 Power Source develops a low distortion, highly stable output of 200 watts maximum over the frequency range from 20 to 20,000 cps with extended range from 10 to 100,000 cps at reduced power. Rms voltages to 1500 volts open circuit and rms currents to 20 amps short-circuit (constant current mode) are available.

The circuitry (Patent applied for) employs a total of 14 tubes, 11 transistors, and a number of diode rectifiers and Zener diodes. Use of positive and overall negative feedback enables the unit to provide an apparent zero output resistance with negligible reactance to 3000 cps when functioning in the constant voltage mode. In the constant current mode of operation the load "sees" an output impedance approximately 30 times that of the rated load impedance.

The output circuit can be matched for load impedances from .72 ohms to 7200 ohms by means of the VOLTAGE CURRENT RANGE selector switch located on the Matching Transformer panel. A large plate dissipation reserve permits continuous full output with a downward load mismatch as much as 2:1 in the constant VOLTAGE mode. For loads greater than this the constant CURRENT mode of operation should be utilized.

OUTPUT REGulation in the constant VOLTAGE mode is adjustable for zero variation, rated load to open circuit over a frequency range from 20 to 3000 cps by means of a panel mounted screwdriver adjustment.

1.3.2 Physical Description

Physically the AC-101 consists of a cabinet containing four rack panels utilizing 26-1/4 inches of rack space. The four panels are the Oscillator, AC line Power Panel, Amplifier, and Matching Transformer. When the optional Ratio Transformer is included, 3-1/2 inches of rack space is added making a total of 29-3/4 inches.

1.3.3 Essential Characteristics

The essential electrical characteristics of the AC-101 are listed in Table 1-1. Table 1-2 lists the dimensions and weights of the unit and the tube and semi-conductor complement is tabulated in Table 1-3.

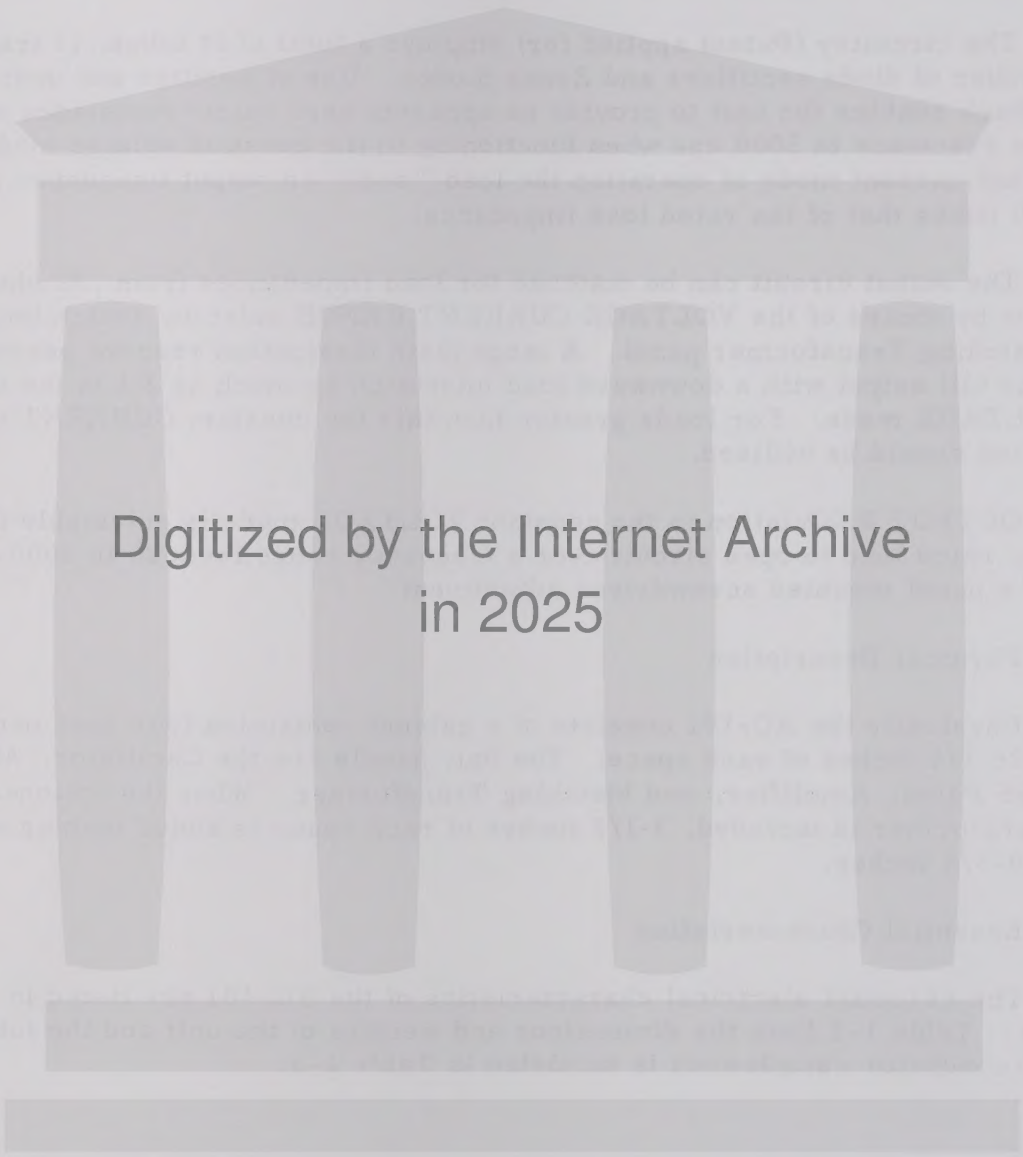
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Table 1-1

Essential Electrical Characteristics of
AC-101 Laboratory Power Source

CHARACTERISTIC (after 1 hour warm-up)	Value or Description
FREQUENCY	
Range, basic @ 200 Watts ± 1 db	20 to 20,000 cps
@ reduced power & specifications	10 to 100,000 cps
Calibration accuracy (In CALIB. position)	Within 1.0%
Resolution	3 decimal digits
Stability, short term, constant temperature	Within 0.01%
PURITY	
Distortion @ 200 Watts ± 1 db, 20 to 10,000 cps (see par. 4.2.5b)	< 0.1%
20,000 cps	< 0.2%
Typical distortion @ lower power levels	< 0.05%
Hum & Noise	< 0.005% of rated output
AMPLITUDE	
Stability, time to make a measurement, 5 to 10 minutes	Within 0.01%
with 10% line voltage change (see par. 4.2.5a)	Within 0.01%
Line intermodulation, at or near line frequencies	< 0.05%

OUTPUT

	RMS Voltage		RMS Current	
Meter Range	Full load [1] 20 cps-10KC	No Load 25 cps-20KC	Full Load	Short Circuit [2]
16V/20A	0-12V	0-15V	0-16.5A	20A
40V/8A	0-30V	0-37.5V	0-6.7A	8A
80V/4A	0-60V	0-75V	0-3.3A	4A
160V/2A	0-120V	0-150V	0-1.6A	2A
400V/.8A	0-300V	0-375V	0-0.67A	0.8A
800V/.4A	0-600V	0-750V	0-0.33A	0.4A
1600V/.2A	0-1200V	0-1500V	0-0.16A	0.2A
Amplifier Direct [3]	0-125V	0-150V	0-2A	2A

@ 10 and 50,000 cps typical Full load 0-400V; No load 0-700V.

(1) @ 20,000 cps Full load 0-1000V, etc.

(2) Constant current regulation only

(3) In AMPLIFIER DIRECT output can be obtained to 100,000 cps, Full load 0-50V., No load 0 - 100V.

POWER REQUIREMENTS, 105 to 125 VAC, 60 to 400 cps, 6.6A @ rated output.

Table 1-2

Dimensions & Weights

AC-101 Laboratory Power Source

	H	W	D
CABINET, overall	34"	23"	18"
PANEL SPACE utilized	29-3/4"	19"	11" max.

WEIGHT, NET complete . . . . . 215 lbs.

WEIGHT, SHIPPING in 4 containers

1. Oscillator . . . . . 25 lbs.
2. Amplifier . . . . . 80 lbs.
3. Matching Transformer . . . . . 60 lbs.
4. Cabinet, with Power Panel, Optional Ratio-Tran. . . 110 lbs.

Total Shipping . . . . . 275 lbs.

These weights subject to change.

Table 1-3

Tube and Semiconductor Complement

TYPE		REFERENCE DESIGNATION	TOTAL
Oscillator RCD-4AR	6DJ8/ECC888	V1	1
	2N697	Q1, Q4, Q5	3
	2N2084	Q2	1
	T1495	Q3	1
	2N669	Q6	1
	2N1306	Q7	1
	2N1183	Q8	1
	CD34381*	CR3	1
	1N712*	CR4	1
	CD34371*	CR5	1
	1N456	CR7	1
	1N3254	CR8, 9, 10, 11	4
	1N4039B*	CR12	1
	1N91	CR13, 14, 15, 16	4
	1N456A	CR17, 18	2
Amplifier PA250D	7025	V1	1
	7247	V4	1
	7323	V5	1
	ECL86	V2, V3	2
	EL34	V6 through V13	8
	1N456A	D11, D12, D13, D14	4
	1N625	D16, D17	2
	1N1767*	Z4	1
	1N1775*	Z1	1
	1N1785*	Z5	1
	1N1793*	Z2, Z3	2
	1N3254	D1, D2, D7, D8, D9, D10	6
	1N3255	D3, D4, D5, D6	4
	2N1305	Q3	1
	2N1306	Q1, Q2	2

* Or equivalent

Section II

INSTALLATION

2.1 PACKING AND INSPECTION

2.1.1 Unpacking

The AC-101 is normally shipped in four containers. The Oscillator, Amplifier, and Matching Transformer are all shipped in separate 2-section "shell-within-a-shell" heavy duty cardboard containers. This is done to minimize the possibility of damage in transit. The fourth container holds the cabinet with the line Power Panel and optional Ratio Transformer (when ordered) already mounted in place.

NOTE

BECAUSE OF THE WEIGHT OF THE AMPLIFIER CHASSIS AND THE MATCHING TRANSFORMER CHASSIS, IT IS RECOMMENDED THAT TWO PERSONS BE USED TO LIFT THEM.

Save all packing materials to simplify repackaging if reshipment should become necessary.

2.1.2 Inspection

Inspect each unit for freedom from shipping damage as soon as it is unpacked. In particular make the following checks:

1. Make sure that no tubes are broken and that all tubes are firmly seated in their sockets. Also, insure that all transistors mounted in heat sinks are firmly seated in their heat sinks.

2. Make sure that all other components are free of apparent physical damage.

3. Check that all knobs are tight on their shafts and that they do not bind when turned. Operate controls and switches and check for smoothness of operation. Any binding or jamming indicates abnormal mechanical operation and should be

investigated and corrected before operating the unit. Do not force any controls that do not turn freely or permanent damage may result.

THE AC-101 IS INSURED FOR SAFE DELIVERY. IF ANY SHIPPING DAMAGE IS FOUND, TAKE IMMEDIATE STEPS TO FILE A DAMAGE SHIPMENT CLAIM WITH THE CARRIER THAT DELIVERED THE INSTRUMENT AND CONSULT WARRANTY STATEMENT AT REAR OF THIS MANUAL.

2.2 INSTALLATION REQUIREMENTS

2.2.1 The AC-101 Power Source requires the space indicated in Figure 2-1. To install the Oscillator, Amplifier, and Matching Transformer chassis, it will be easiest if the cabinet is laid down flat with the front facing upward. To protect the cabinet put one of the rubber corner blocks from the packing materials under each corner while cabinet is laid down. The various chassis can then be lowered into place and fastened with the mounting screws and washers provided. Note that the Oscillator panel is 3/16 inch thick compared to 1/4 inch thickness on the Amplifier and Matching Transformer. Four shimming washers 1/16 inch thick are provided to be mounted underneath the Oscillator panel so that its surface will be flush with that of the other chassis.

The amplifier chassis has a "drop-down" front panel to facilitate access to the under side of the chassis without having to pull the amplifier out of the cabinet. After lowering the amplifier in place in the cabinet, loosen the two thumbscrews on the front panel and raise it upright. This will expose the rack mounting chassis flanges. The Amplifier is mounted with 8 mounting screws provided. The chassis should be mounted in the cabinet in accordance with Figure 2-1.

THE AMPLIFIER CHASSIS HAS A MUFFIN TYPE FAN FOR COOLING OF THE OUTPUT TUBES. IT IS ESSENTIAL TO KEEP THE AREA AROUND THE LOUVERS IN THE CABINET CLEAR FOR ADEQUATE VENTILATION. THESE LOUVERS PROVIDE AIR EXHAUST FOR THE BLOWER.

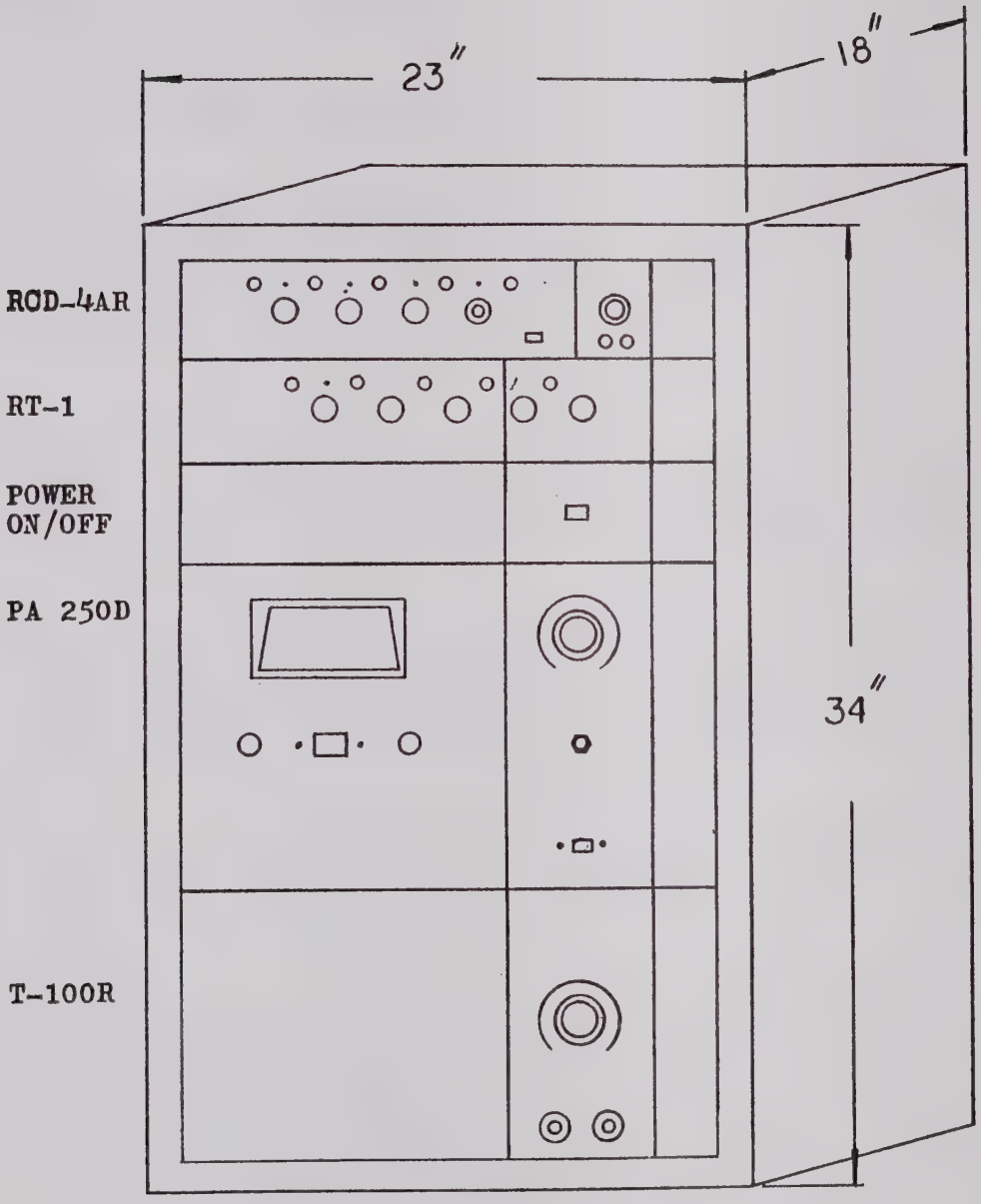


Figure 2-1
AC-101 Outline Dimensions

2.2.2 Connecting Input, Output, and Line Power Leads.

a. Figure 2-2 shows the rear interconnections for the AC-101. The shielded cable labeled INPUT should be connected at one end to the GR connectors on the rear of the Oscillator marked AMP. and at the other end to the GR connectors on the Amplifier INPUT terminals.

CAUTION!

INSURE THAT THE SHIELD SIDE OF THE GR CONNECTOR IS PLUGGED INTO THE BLACK TERMINAL AT EACH END OF THE INPUT CABLE, OTHERWISE THE OUTPUT OF THE OSCILLATOR MAY BE SHORTED TO GROUND.

b. The cable labeled OUTPUT runs from the Amplifier OUTPUT terminals to the selector switch of the Matching Transformer, T-100R. The Amplifier end of the cable has two mounting lugs that are to be secured to the Amplifier OUTPUT terminal strip with the white wire connected to the "HI" terminal and the black wire connected to the "LO" terminal.

c. The meter cable is labeled meter and has an RCA plug on each end. It is to be connected to the meter receptacle on the amplifier and the RCA receptacle on the metering selector switch shield on the Matching Transformer chassis.

d. Ratio Transformer when furnished. When the optional Ratio Transformer is furnished with the AC-101, an additional short input cable is furnished. Connect this short cable from the output of the Oscillator marked RT to the INPUT terminals of the Ratio Transformer, again insuring that the shielded side of the cable is connected to the ground or common side of the Oscillator and Ratio Transformer. The longer input cable is connected from the OUTPUT terminals of the Ratio Transformer to the INPUT terminals of the Amplifier (as in paragraph a. above).

e. A power receptacle strip is provided on the back of the Master Switch panel. It contains two AC outlets, one for the Oscillator and the other for the Amplifier. The Oscillator and Amplifier line cords should be plugged into these receptacles. When the individual power switches on the Amplifier

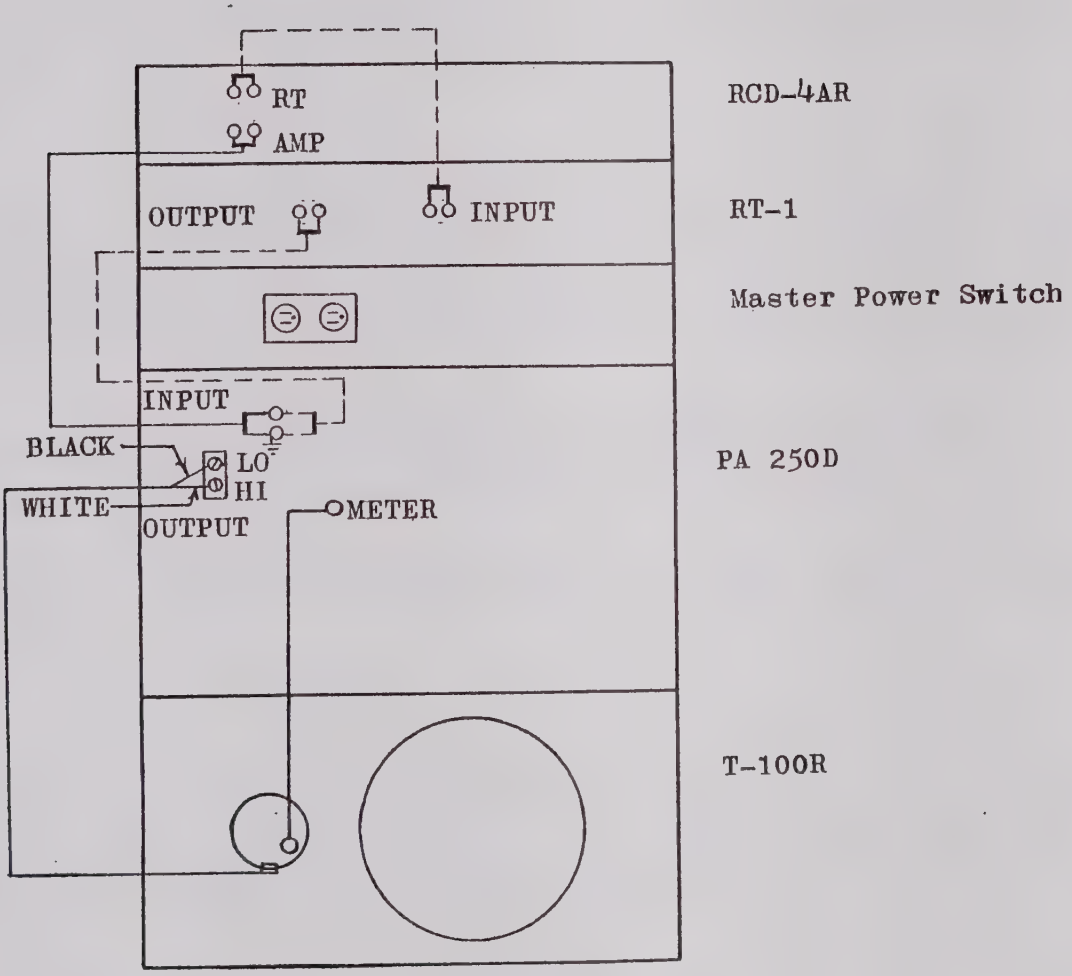


Figure 2-2
Chassis Interconnection, rear view

and Oscillator, respectively, are turned ON, then the main POWER switch will control power to each individual chassis.

NOTE: Individual power switches are provided on both the Amplifier and Oscillator so that these units can be operated independently if desired.

f. Connect the load to the OUTPUT terminals located on the front of the Matching Transformer panel.

2.2.3 Length of Output Leads

The length of the output leads is not critical within reasonable limits of 2 or 3 feet. It should be kept in mind, however, that a voltage drop can occur through the leads. If the AC-101 is being used in a zero impedance condition, the impedance of the leads could be an important factor. For example, a 10 foot length of 16-gauge copper wire would introduce an impedance of approximately 40 milliohms into the output circuit.

No. 12 rubber covered copper wire is adequate for all operating conditions of the AC-101 with the output selector switch on any tap. No. 18 wire is adequate for operation utilizing switch position taps from 160 volts up.

The output mating connectors furnished with the Matching Transformer chassis are designed for currents up to 50 amps. They are more than adequate in size for the AC-101.

2.2.4 Electrical Connections

The AC-101 Laboratory Power Source is intended for use with 115 volt 60 cycle line. To protect operating personnel, the cabinet, various chassis, and panel should be grounded. This is accomplished when the 3-conductor power cable is plugged into a proper 3-conductor polarized receptacle. The offset pin on the power cable 3-prong plug is the ground pin.

CAUTION!

OPERATION OF THE POWER SOURCE WITH THE BACK COVER OPEN SHOULD BE DONE WITH CAUTION. THE MATCHING TRANSFORMER HAS AT LEAST 1500 VOLTS ON IT REGARDLESS OF THE SETTING OF THE OUTPUT VOLTAGE SELECTOR (AT MAXIMUM GAIN). 1500 VOLTS AC IS LETHAL! IF IT IS NECESSARY TO CHECK IN THE

REAR OF THE UNIT WITH THE BACK OPEN BE SURE AND DISCONNECT THE OUTPUT CABLE RUNNING FROM THE AMPLIFIER TO THE MATCHING TRANSFORMER BEFORE PROCEEDING.

2.3 PREPARATION FOR RESHIPMENT

If possible, the various chassis should be reshipped in the same containers that they were received. Use the same packing material if it is available.

Section III

OPERATION

3.1 GENERAL

The AC-101 Laboratory Power Source has a minimum number of controls and switches and is relatively simple to operate. This section contains general operating instructions and procedures.

3.2 DESCRIPTION OF OPERATING CONTROLS AND INDICATORS

Figure 3-1 shows the locations of the controls and indicators. Their functions are described below.

a. Oscillator Power Switch: Turns on line power to the Oscillator (master power switch must also be turned on). Frequency digit indicators and decimal point will light when Oscillator is ON.

b. Frequency Selectors: Select the three most significant digits of the desired output frequency. These are displayed in the first 3-digit windows from the left of the Oscillator panel.

c. Frequency Digit Indicators: The 3-digit indicators to the left display the numbers selected by the frequency selectors. The two digits to the right are fixed zeros and are utilized to complete the frequency read-out in cycles per second.

d. DECADE Frequency Range Selector: Selects one of 4 decade frequency ranges and causes the decimal point to light in the correct place for the respective range selected.

e. Decimal Indicators: Indicate the position of the decimal point according to the frequency range selected by the DECADE frequency selector.

f. VERNIER Frequency Control: Allows variation of the output frequency by approximately ± 1.5 per cent of the nominal value indicated by the frequency digit indicators. When the VERNIER Frequency Control is placed in the CALIBrate position, indicated on the panel, it is optimized for best tracking over the entire frequency range of the Oscillator.

g. Output ATTENUATION: The step output attenuator has three fixed steps of 0, -20, and -40 db.

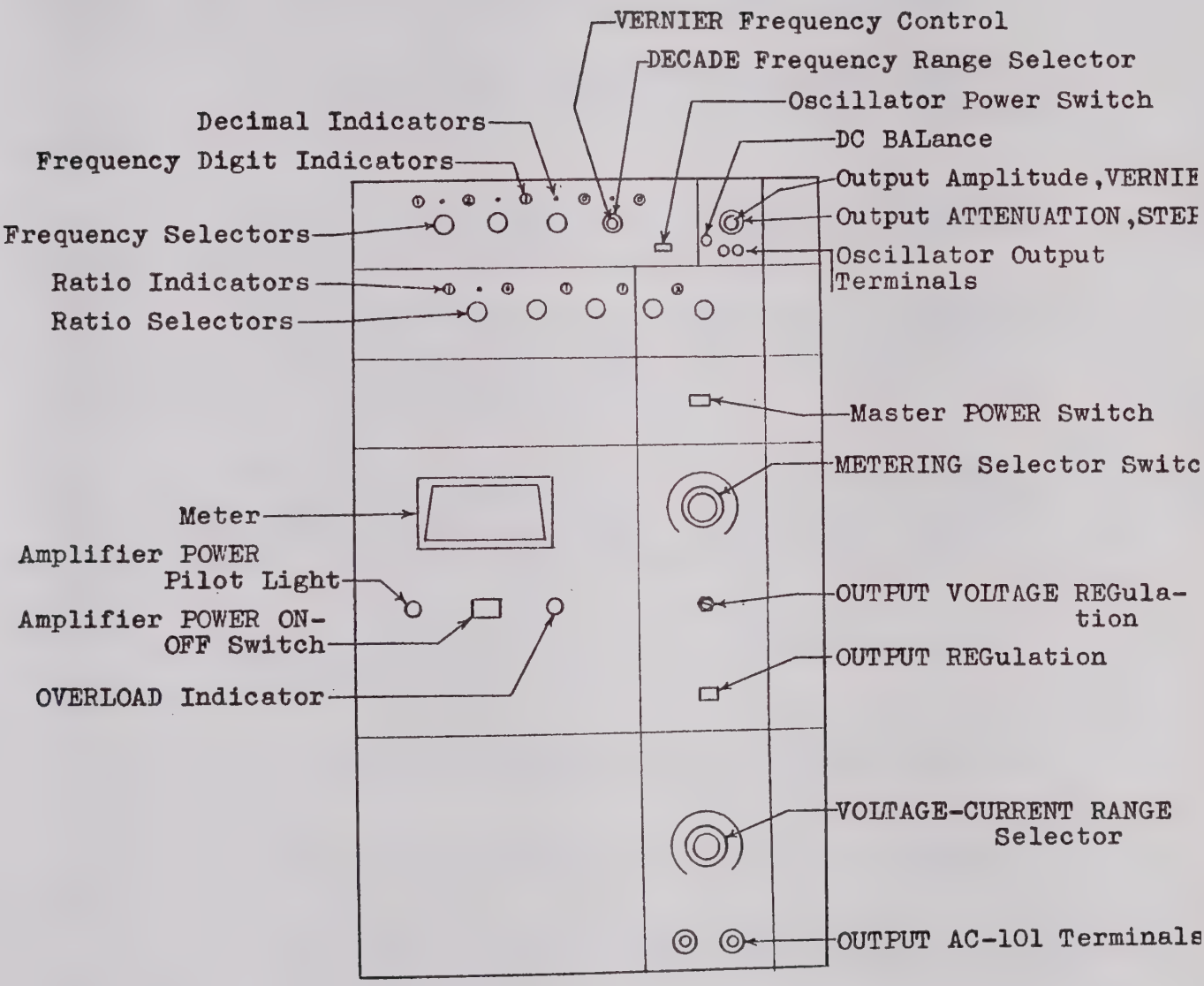


Figure 3-1 Location of Controls and Incicators

h. Output Amplitude VERNIER: Provides a continuous variable amount of output ATTENUATION from zero to full scale of the setting on the STEP attenuator, with a resolution of 0.002 per cent of full scale.

i. D.C. BALance: This is a screwdriver adjustment that allows adjusting the DC component on the Oscillator to essentially zero. See paragraph 3.3.4).

j. Oscillator Output Terminals: These front panel terminals are provided so that the output of the Oscillator can be obtained direct when it is desired to use the Oscillator separate from the rest of the AC-101.

k. Master POWER Switch: This is a self-indicating POWER switch that glows red when line power is ON. To turn it ON press the switch in. Pressing it a second time turns the main power OFF. This switch controls power to the Oscillator and Amplifier line cords.

l. METERING Selector Switch: This switch allows selection of TUBE TEST (each of the eight output tubes cathode current) OUTPUT VOLTAGE, AMP. OUTPUT CURRENT (see para. 4.2.4f). The latter two in accordance with the VOLTAGE-CURRENT RANGE selected and the respective scale on the meter.

m. Meter: The meter indicates either voltage or current as selected by the METERING selector switch.

n. Amplifier POWER Pilot Light: This red light glows when AC power is connected to the Amplifier and the Amplifier ON-OFF switch is in the ON position.

o. Amplifier POWER ON-OFF Switch: Turns on line power to the Amplifier (when the master POWER switch is ON).

p. OVERLOAD Indicator: Lights when the steady state or transient distortion exceeds a nominal value of 1/4 per cent in the mid frequency range.

q. OUTPUT VOLTAGE REGulation Adjustment: This screwdriver adjustment provides the means to set the internal output resistance to zero. (See para. 3.4.1).

r. OUTPUT REGulation: This slide selector switch allows selection of either constant VOLTAGE or constant CURRENT REGulation.

CAUTION!

DO NOT CHANGE THE POSITION OF THE OUTPUT REGULATION SWITCH BEFORE TURNING THE VERNIER AMPLITUDE CONTROL TO ZERO (COMPLETELY COUNTER-CLOCKWISE).

s. VOLTAGE-CURRENT RANGE Selector: Allows selection of one of seven voltage and/or current ranges for the AC-101. An AMPLIFIER DIRECT position is provided to by-pass the matching transformer.

t. OUTPUT AC-101 Terminals: The voltage and/or current output of the AC-101 appears at these terminals in accordance with the VOLTAGE-CURRENT RANGE selected.

3.3 PRELIMINARY PROCEDURES

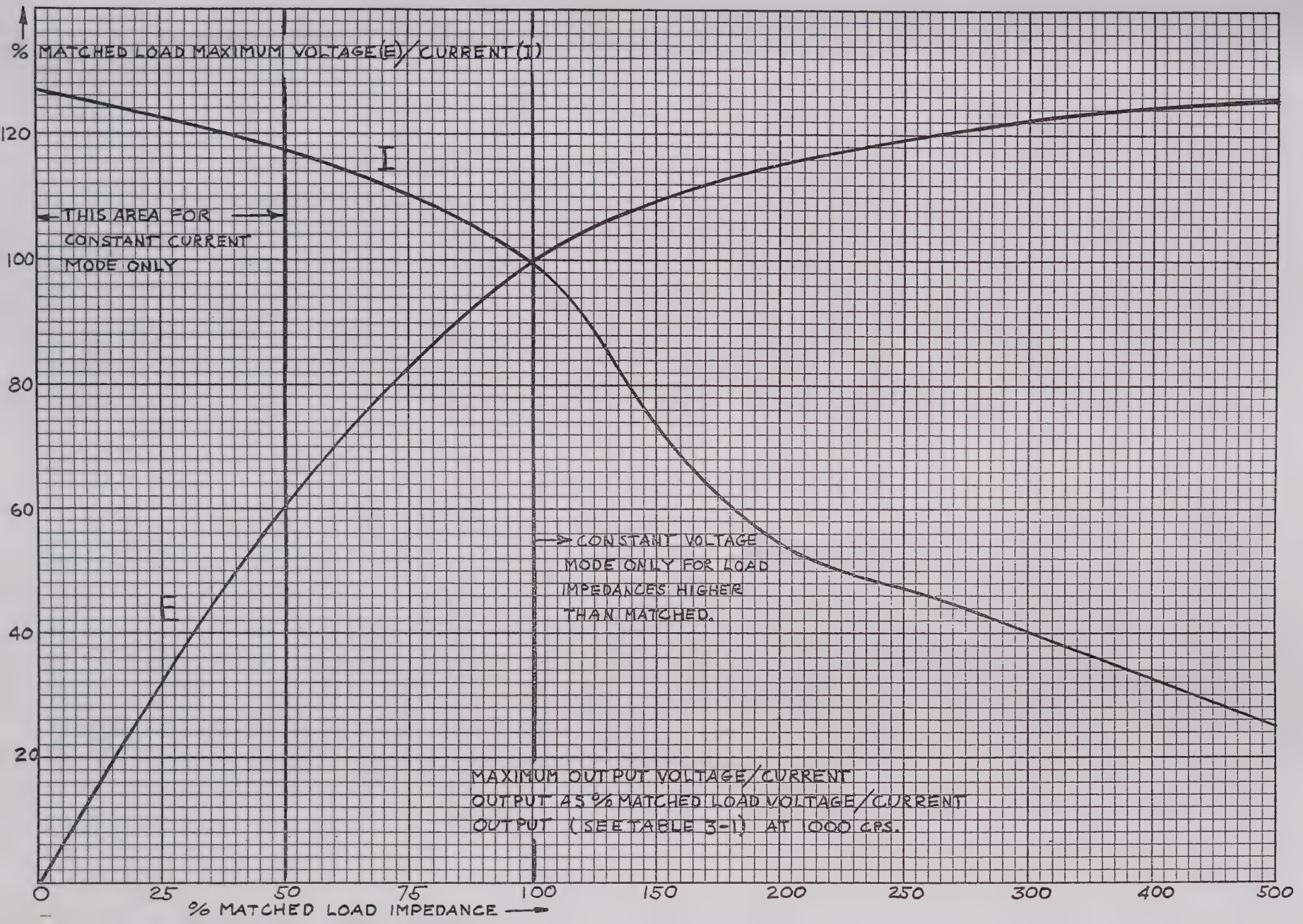
Before the AC-101 Laboratory Source is placed in actual operation, the operator must set certain controls and select the output VOLTAGE CURRENT RANGE according to the specific application. These procedures are described in paragraphs 3.3.1 through 3.3.4. In the following paragraphs it is assumed that the AC-101 has already been installed according to the procedures outlined in Section II.

3.3.1 Selection of VOLTAGE CURRENT RANGE

The VOLTAGE CURRENT RANGE should be selected in accordance with the maximum voltage or current desired. When possible the AC source should be operated on a voltage or current range near the maximum value; i.e., if a 100 volt output is desired the RANGE selector should be set on the 160 volt tap. If a 300 volt output is desired the 400 volt tap should be utilized, etc. Figure 3-2 shows typical maximum output voltage as a function of % nominal load impedance.

In general constant VOLTAGE OUTPUT REGulation should be selected for load impedances that are rated load or lighter. Downward mismatches up to 2:1 can be utilized in the constant voltage mode without damage to the output tubes.

When utilizing load impedances that are lower than nominal for the lowest voltage tap, the constant CURRENT mode of OUTPUT REGulation should generally be used.


% MATCHED LOAD MAXIMUM VOLTAGE (E) / CURRENT (I)
120
100
80
60
40
20
I
THIS AREA FOR CONSTANT CURRENT MODE ONLY
E
CONSTANT VOLTAGE MODE ONLY FOR LOAD IMPEDANCES HIGHER THAN MATCHED.
MAXIMUM OUTPUT VOLTAGE/CURRENT OUTPUT AS % MATCHED LOAD VOLTAGE/CURRENT OUTPUT (SEE TABLE 3-1) AT 1000 C.P.S.
0
25
50
75
100
150
200
250
300
400
500
% MATCHED LOAD IMPEDANCE

As the load on the Amplifier becomes greater than rated load in the constant voltage mode the distortion will rise. Conversely, in the constant current mode as the load becomes less than rated load the distortion will rise. The reason for this is as follows:

When the Amplifier is operating in the constant voltage mode the feedback is obtained in effect from across the load. As the load approaches a short circuit, the open loop gain of the Amplifier - and hence its feedback - is reduced, resulting in higher distortion. In the constant current mode the Amplifier derives the greatest amount of feedback with a short circuited load, and is therefore most stable under this condition.

CAUTION!

WITH A DOWNWARD MISMATCH GREATER THAN 2:1 THE CONSTANT CURRENT MODE OF REGULATION MUST BE USED TO AVOID DAMAGE TO THE OUTPUT TUBES. ALSO, OPERATION WITH A SHORT CIRCUIT ON THE OUTPUT SHOULD BE LIMITED IN DURATION SO AS NOT TO SHORTEN THE OUTPUT TUBE LIFE.

Table 3-1 lists values of matched load impedance versus output voltage and current at the maximum 200 watt level. Figure 3-3 shows the maximum percentage of undistorted power that can be safely used with loads other than nominal or matched. This is shown as a function of per cent nominal load impedance.

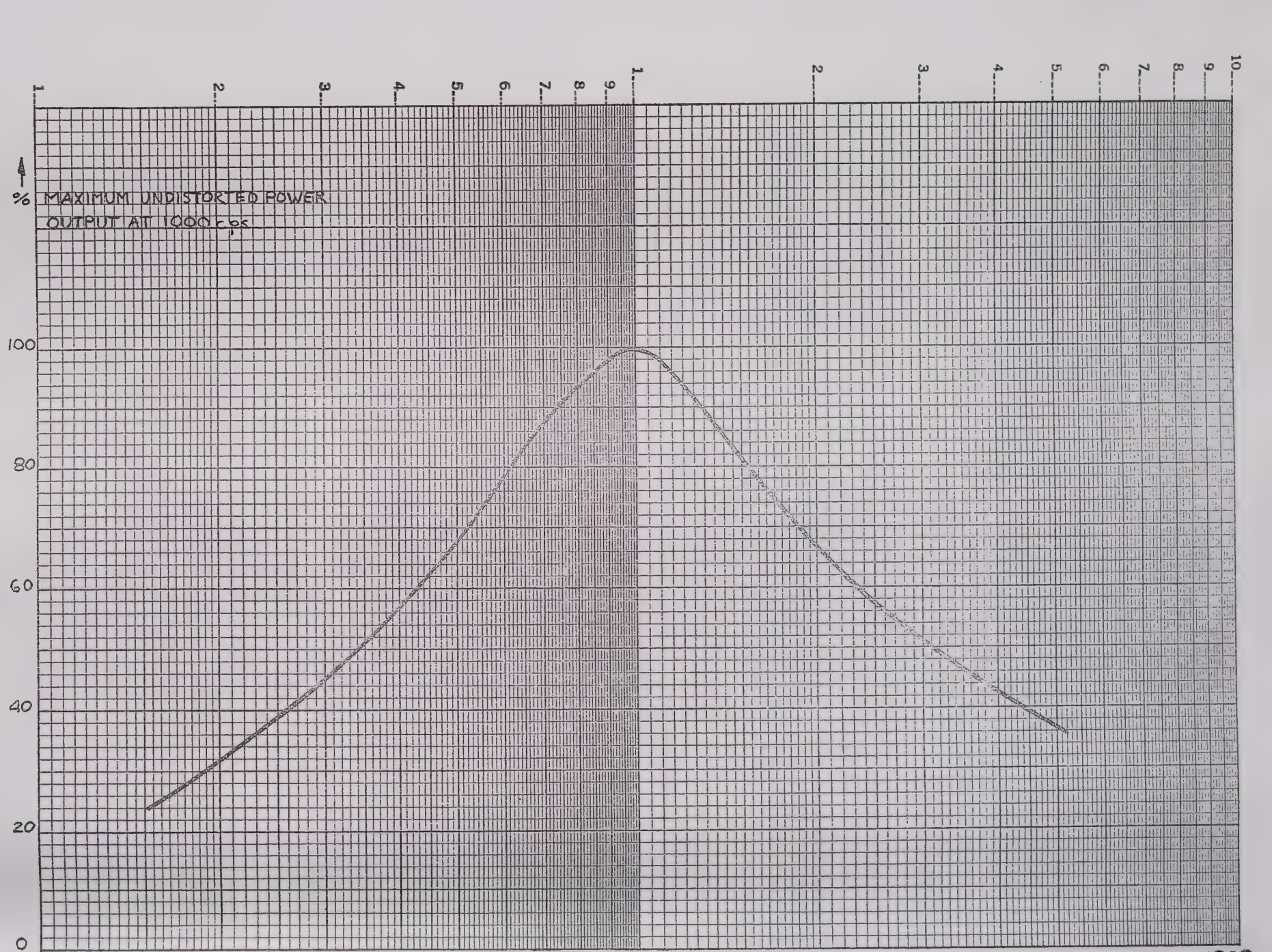
3.3.2 Selection of Constant VOLTAGE or Constant CURRENT Output REGulation.

The selection of either constant CURRENT or constant VOLTAGE mode of operation is dependent primarily on the specific application. In general the constant VOLTAGE mode will be utilized as most electrical devices are designed to operate on a constant VOLTAGE source. The constant CURRENT mode of operation should be utilized (as mentioned in paragraph 3.3.1) when a load impedance is being used that is lower than the maximum rated load on the lowest VOLTAGE RANGE tap. This usually occurs when testing ammeters. The constant CURRENT mode should also be used when a requirement exists for the load current to remain constant as a function of frequency and independent of variation of load impedance or phase angle of the load impedance.

Table 3-1

Matched Load Impedance for
200 Watt Output

VOLTAGE-CURRENT RANGE Tap	Matched Load Z	Output Current	Output Voltage
16V/20AMP	0.72 ohms	16.5A	12V
40V/8 AMP	4.5 ohms	6.7A	30V
80V/4 AMP	18 ohms	3.3A	60V
160V/2AMP	72 ohms	1.6A	120V
400V/.8AMP	450 ohms	0.67A	300V
800V/.4AMP	1800 ohms	0.33A	600V
1600V/.2AMP	7200 ohms	0.16A	1200V
AMP Direct	60 ohms	2A	125V


MAXIMUM UNDISTORTED POWER
OUTPUT AT 1000 cps
%
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10

CAUTION!

WHEN SWITCHING BETWEEN CONSTANT CURRENT AND CONSTANT VOLTAGE OPERATING MODES REDUCE THE GAIN TO ZERO. FAILURE TO DO THIS MAY CAUSE THE AMPLIFIER TO GO INTO A SEVERE OVERLOAD CONDITION OR IN THE CASE OF AN INDUCTIVE LOAD INDUCE SHARP TRANSIENTS INTO THE OUTPUT. EITHER CONDITION CAN RESULT IN DAMAGE TO THE AMPLIFIER.

3.3.3 Checking Balance of Output Tubes

For maximum power output at lowest distortion, the cathode current of each output tube should be close to the same value. The METERING switch includes eight positions to permit the meter to indicate each output tube current individually. To check the balance of the output tubes proceed as follows:

a. Make sure that the VERNIER output amplitude control is at zero (fully counter-clockwise). Set METERING switch to V-6.

b. Turn POWER switch ON and allow one minute for the Amplifier to warm up.

c. Observe meter indication with METERING switch at V-6. While still observing meter indication, turn METERING switch successively to V-7 through V-13. Each output tube V-6 through V-13 should indicate cathode current within the TEST area on the meter scale. To read cathode current directly in milliamps use the meter scale with a full scale reading of 80. The tube currents will run between 20 and 40 milliamps. If the current of any tube is higher than 40 milliamps (the limit of the meter TEST area) adjust R-18 (see Figure 3-4) until the highest tube current (V-6 through V-13) is no higher than 40 milliamps. It is permissible for the current of a tube to be slightly below 20 milliamps, but if the current of one tube is considerably below that of the others, the tube should be replaced and R-18 re-adjusted until the currents of all tubes are closely matched within the TEST area on the meter.

3.3.4 Adjusting the DC BALance Control.

With the Amplifier POWER switch turned OFF, turn on the Oscillator power, set ATTENUATION STEP and VERNIER for maximum output, and test the output terminals on the front of the Oscillator panel for DC voltage. A multimeter or VTVM should be utilized with a full scale reading of 1 to 1-1/2 volts DC. If there appears to be more than a few millivolts of DC the control should be adjusted as follows:

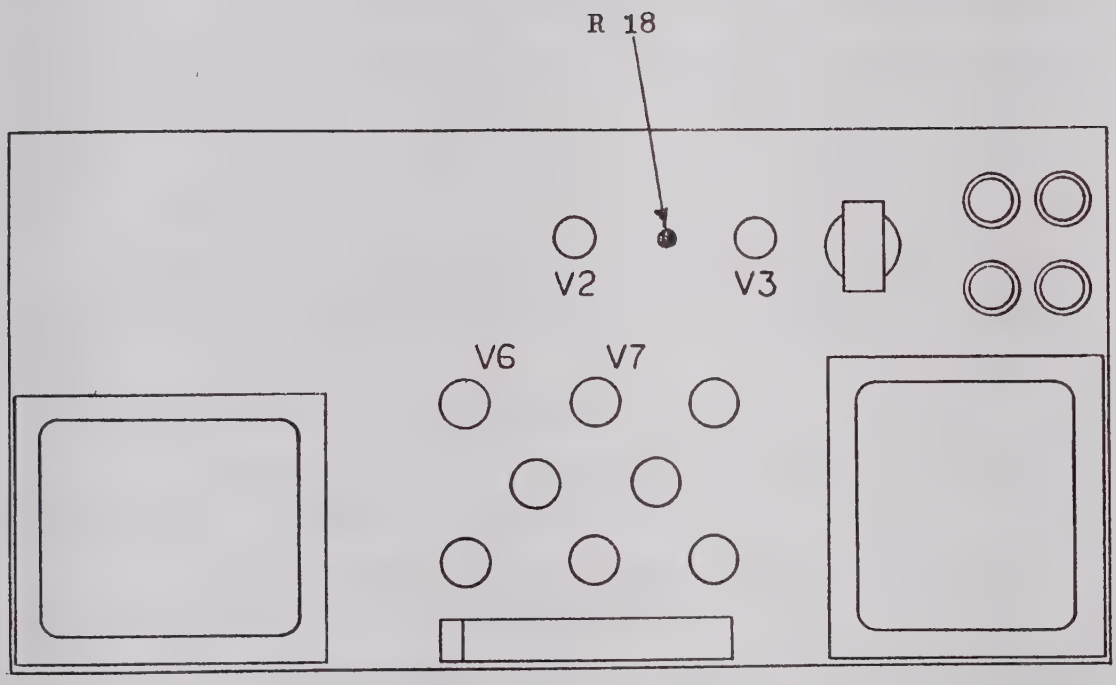


Figure 3-4
Location of R 18 (PA 250D)

a. Set frequency to 1000 cps.

b. Set STEP attenuator and amplitude VERNIER control to maximum output level (fully clockwise).

c. Attach VTVM or multimeter to Oscillator output terminals.

d. Adjust DC BALance control for zero indication on the meter.

NOTE: The DC BALance control should require very infrequent adjustment.

3.4 OPERATION

Before power is applied to the AC-101 Laboratory Source, be sure that the VERNIER output amplitude control is set at zero (fully counter-clockwise). Proceed as follows:

a. Connect the load desired.

b. Select the correct VOLTAGE or CURRENT tap in accordance with information presented in paragraph 3.3.1.

c. Put the Oscillator and Amplifier individual power switches to the ON position and press the master POWER switch to the ON position.

d. Select the frequency desired with the frequency selectors and the DECADE frequency range selector. The decimal point will appear in the correct position to read out frequency directly in cycles per second.

e. On AC-101's having the optional Ratio Tran chassis set the voltage ratio dials to 1.0000.

f. Slowly turn the ATTENUATION VERNIER control clockwise while observing the meter until the desired output is applied to the load.

NOTE: Do not attempt to make any precise measurements of the output voltage until the AC-101 has had a chance to warm up for at least ten minutes. To insure that the AC-101 complies with the electrical characteristics in Table 1-1, at least one hour warm-up is required.

g. If the constant VOLTAGE mode of operation has been selected and if zero output resistance is important to the particular application, it may be necessary to adjust the OUTPUT VOLTAGE REGulation control located on the Amplifier front panel. If this is true, follow the procedure given in paragraph 3.4.1.

3.4.1 Adjusting the AC-101 for Zero Output Resistance

CAUTION!

INSURE THAT PRIOR TO MAKING THIS ADJUSTMENT THE OUTPUT REGULATION SELECTOR SWITCH IS IN THE VOLTAGE POSITION. IF THIS ADJUSTMENT IS ATTEMPTED IN THE CURRENT POSITION DAMAGE TO THE AMPLIFIER MAY RESULT. THE REASON FOR THIS IS EXPLAINED IN PARAGRAPH 4.2.5c.

a. It is assumed that the output voltage of the AC-101 has been set in accordance with the procedures outlined in paragraph 3.4 and that the OUTPUT REGulation selector is in the VOLTAGE position. Connect a voltmeter across the leads going to the load at the load. (The AC-101 meter can be used for this adjustment but it is best to use an external meter since the built-in meter is not always connected "across" the load, if the output leads have significant impedance.)

b. With the load connected observe the indication on the external voltmeter. Disconnect and connect the load while adjusting the OUTPUT VOLTAGE REGulation control until the voltmeter indication is the same with the load connected or disconnected. When this condition is obtained the effective output resistance of the AC-101 is zero.

NOTE: The setting for OUTPUT VOLTAGE REGulation will remain the same over a frequency range from 100 to 1000 cycles for a particular voltage tap. If the voltage selector is changed to a different tap, or if the frequency range is changed, it may be necessary to readjust the OUTPUT VOLTAGE REGulation control for zero output resistance. If frequencies over 1000 cycles are used, the output resistance will tend to go positive, for frequencies lower than 100 cycles, the output resistance will tend to go negative. Both of these changes in output resistance are with respect to the setting obtained within the frequency range of 100 to 1000 cycles. It is possible to adjust the output resistance to essentially zero to frequencies slightly above 3000 cycles.

3.4.2 Standardizing the AC-101 Output for Utilization of the Ratio Transformer

On those units supplied with the optional Ratio Transformer the output voltage can be standardized so that voltage may be dialed in and read directly on the Ratio Transformer. This is a desirable feature for calibrating meters. Even though the specification for amplitude stability is 0.01 per cent for "time-to-make-a-measurement" (five to ten minutes) in actual practice it will be found that the amplitude will remain within 0.01 to 0.02 per cent for thirty to sixty minutes at a time. This is especially true after a long warm-up period and with constant ambient temperature and constant line voltage. For longer periods of time, up to several days, the amplitude will usually remain well within 0.1 per cent.

These facts permit the AC-101 to be utilized as a voltage standard after the output has been standardized by use of a thermal transfer standard or other precise measuring device. To set up the AC-101 for this purpose, proceed as follows:

a. Allow at least 1 hour warm-up in a constant ambient temperature room.

b. Set the Ratio Transformer to 1.0000.

c. Select the desired full scale voltage range on the VOLTAGE CURRENT RANGE selector. i.e., if a voltage range up to 100 volts is desired, set the RANGE selector switch to the 160 Volt range.

d. Following the above example, adjust the output amplitude VERNIER control until exactly 100.00 volts is obtained from the source as measured with an AC thermal transfer standard or other precise instrument.

NOTE: The load on the source should be the same as the load to be utilized during testing.

e. After calibration the source can now be utilized by dialing in any voltage desired from 0 to 111.11 volts with the Ratio Transformer.

If the frequency is changed it will be necessary to recalibrate and standardize the output voltage.

Section IV

PRINCIPLES OF OPERATION

4.1 INTRODUCTION

This section describes the principles of operation for the AC-101 Laboratory Power Source. To simplify understanding of the system the description is presented in two major parts:

1. Over-all functional operation on a block diagram basis.

2. Detailed analysis of each chassis that make up the over-all system.

It is recommended that any person attempting to adjust or trouble-shoot the AC-101 should read and thoroughly understand the material presented in this section before any work is done on the unit.

4.2 OVER-ALL FUNCTIONAL DESCRIPTION

The AC-101 functional block diagram, Figure 4-1, indicates the major functional units and their interconnection. Basically, the AC-101 consists of an Oscillator with a high resolution output ATTENUATION control which optionally feeds a Ratio Tran, that can be used to adjust the Oscillator output in precise steps. The Oscillator output drives the Amplifier which features an extremely accurate and constant gain of 120. The output of the Amplifier is applied to the power Matching Transformer which allows selection of seven different voltage-current ranges in addition to a by-pass position where output is obtained directly from the Amplifier.

Both the Oscillator and Amplifier have their own individual power supplies.

4.2.1 Oscillator

Figure 4-2 shows a simplified equivalent circuit for the RCD series of Oscillators. Basically, the Oscillator consists of a differential amplifier having a highly stable gain of 30 with positive feedback applied through the network of R-2 and R-1 and negative feedback applied through the bridged-T frequency determining network. When the net feedback applied

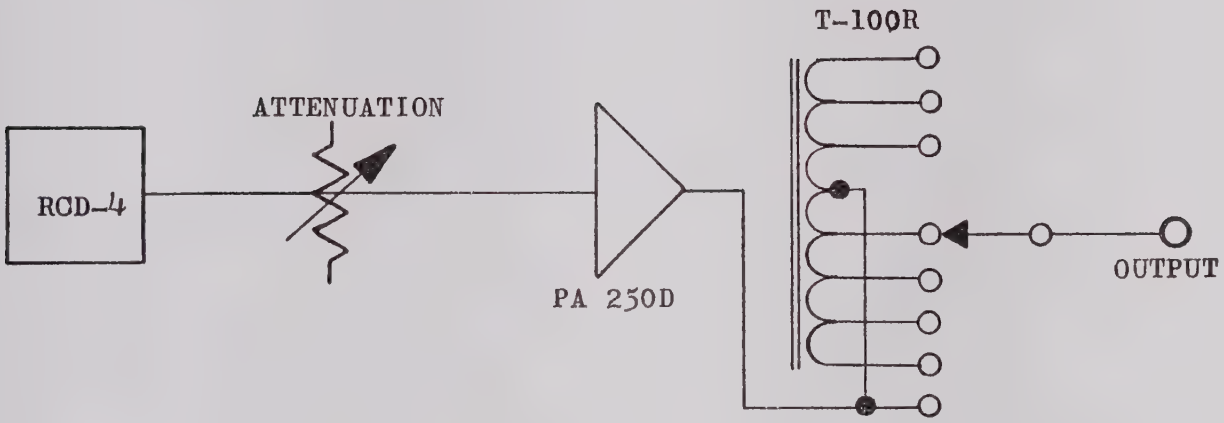


Figure 4-1
AC-101 BLOCK DIAGRAM

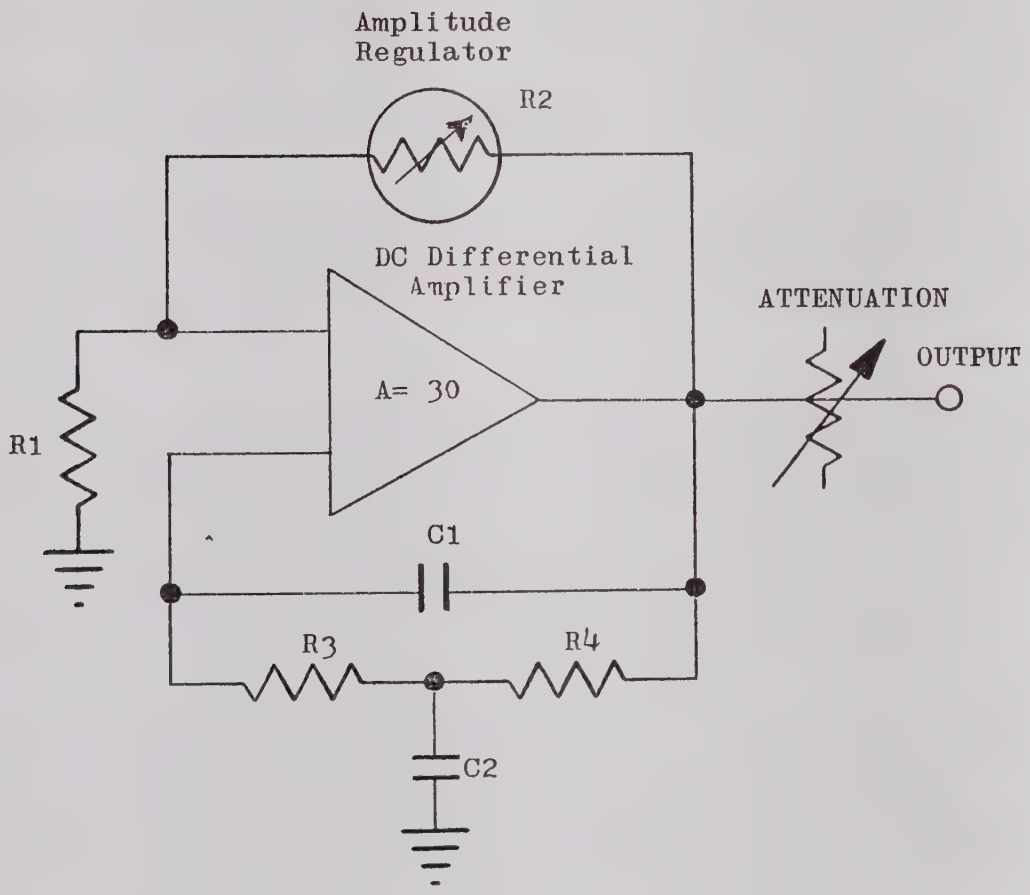


Figure 4-2
RCD OSCILLATOR EQUIVALENT CIRCUIT

to the amplifier is positive the unit will oscillate at a frequency where the transmission characteristic is at minimum and the phase shift is zero (Figure 4-3).

a. When the oscillator is first turned on approximately one-half of the output voltage of the amplifier is applied through the positive feedback loop to the input of the amplifier.

b. The negative feedback is approximately one-third of the output amplitude at the frequency of oscillation and remains constant.

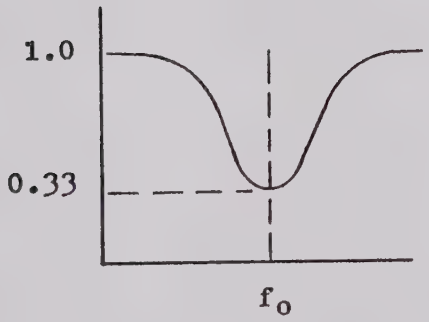
c. Since the positive feedback is greater than the negative feedback the unit will immediately go into oscillation.

d. As R-2 warms up its resistance value goes up and the positive feedback is reduced. The positive feedback stabilizes at a value slightly above the amount of negative feedback. Since the nominal output of the Oscillator is 5 V rms and the amplifier gain is 30, then the excess positive feedback is $\frac{5}{30}$ V.

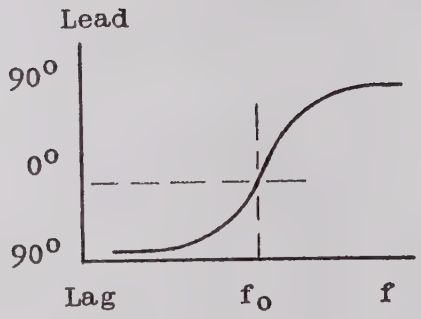
e. R-2 is the stablizing element and consists of a special designed lamp having a very mechanically stable tungsten resistive element in a vacuum. It provides amplitude stabilization for the Oscillator and works as follows: If the output amplitude of the Oscillator tends to go up the voltage across R-2 increases thereby increasing the temperature of R-2 which in turn increases its resistance. This causes the amount of positive feedback applied to the differential amplifier to decrease. The net signal into the differential amplifier is thereby lowered to the original value stabilizing the output amplitude.

The amplitude stabilization element R-2 is very sensitive and requires very low power to exercise precise amplitude control. Actually it consumes less than 1/20th of a watt. The excellent control of the amplitude stability element in conjunction with the high gain stability of the differential amplifier without feedback combine to provide the very high order of amplitude stability in the RCD series of Oscillators.

f. The bridged-T frequency determining network has transmission characteristics illustrated in Figure 4-3. At the frequency of oscillation transmission is at a minimum and phase shift is zero. The ratio of C-1 to C-2 determines the steepness of the slope of the transmission characteristic. This steepness in part determines the degree to which harmonics are attenuated. The ratio of C-1 to C-2 is 4:1, an optimum value taking into consideration steepness and practical size of capacitors. For example, with the bridged-T



Transmission Characteristic



Phase Shift

Figure 4-3
Bridged T Characteristics

network utilized in the RCD Oscillators the response to the second harmonic of the frequency of oscillation, is up 6 db through the bridged-T network. This third harmonic is up 10 db, and high order harmonics approach a maximum of about 20 db. Therefore, since the bridged-T network is supplying negative feedback, the distortion due to the second harmonic is reduced by one-half (compared to the amplifier alone); the third to one-third, and high order harmonics to one-tenth of their value in the differential amplifier alone. It is interesting to compare this with the standard Wein bridge oscillator which uses a capacitor ratio of 1:1. The 1:1 ratio means that the Wein bridge has a lower equivalent Q factor and therefore does not have the distortion reducing properties of the 4:1 bridged-T. Hence, in general for a particular differential amplifier the distortion of the Wein bridge oscillator will be higher.

4.2.2 Oscillator Circuit Description

Figure 4-4 shows a more detailed functional block diagram of the RCD Oscillator series. In following this discussion it will be useful to refer to the schematic diagram of the Oscillator at the rear of this handbook.

The differential amplifier basically is contained in V1 a dual triode. Q1 is utilized to provide a constant source of cathode current to V1. Q2 supplies a constant source of plate current to V1A. Looking at Q1 and Q2, V1 sees a very high impedance. Hence, the current from Q1 and Q2 is constant. In this configuration the gain of the differential amplifier approximates the mu of the tube which is about 30. This gain remains constant over a wide range of external parameters. Since the mu of the tube is determined primarily by the spacing of the elements within the tube, the gain remains fixed. This circuit is unique and the subject of a Patent Application.

One side of the differential amplifier input is fed by the bridged-T network supplying negative feedback. The other side of the differential amplifier is fed by the amplitude stability regulator which supplies positive feedback.

The output impedance of V1 is relatively high. This is reduced to a low value by the impedance changing action of Q3 and Q4, a cascaded transistor power output stage connected in an emitter follower configuration. The output impedance of this impedance changer is near zero. The excellent frequency stability of the RCD Oscillator series is in part due to this near zero output impedance and the nearly infinite input impedance of the V1 differential stage. Q5 is a constant current source for Q3 and Q4. To minimize the recovery time when switching frequencies, diodes CR-17 and 18 are utilized. As the frequency is switched the output amplitude tends to rise. Due to the thermal time lag of the amplitude stability regulator it takes a number of cycles before

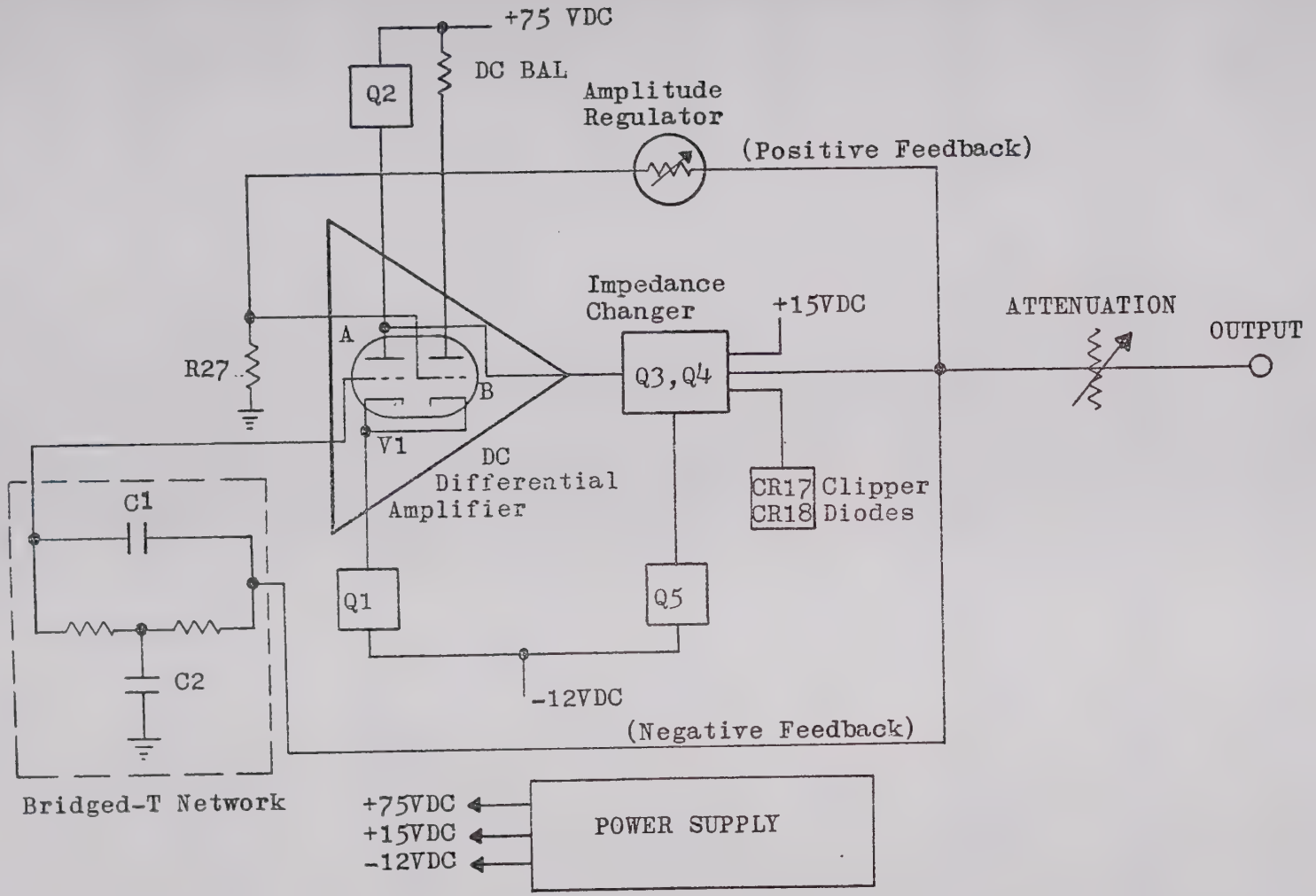


Figure 4-4
RCD OSCILLATOR BLOCK DIAGRAM

the amplitude is stabilized. In order to minimize the time required for the signal to restabilize, these diode clippers are set approximately 5 per cent above the nominal output amplitude. When the signal attempts to rise, due to switching frequency, it is clipped by the diodes thus allowing the amplitude stability regulator to "catch up". At high frequencies the recovery time is a fraction of a second. At low frequencies it will be in the order of one to two seconds.

The power supply provides all voltages necessary for proper Oscillator operation. The power supplies are extremely well regulated and the circuitry insures good isolation from line voltage variations. DC on tube filaments insure freedom from line beat.

The Oscillator has a stepped attenuator with fixed steps of 0, -20 and -40 db. For VERNIER control the Oscillator features a 0.002 per cent full scale resolution, 3-decade potentiometer. This potentiometer has (on a single shaft) a coarse, medium, and fine adjustment.

4.2.3 Amplifier

This paragraph describes the principles of operation of the PA250D Amplifier.

The PA250D functional block diagram, Figure 4-5, indicates the major functional blocks and their interconnections. Figure 4-5 shows that, as far as the incoming source signal is concerned, the Amplifier consists basically of the input stages (V1A and Q1) driving the phase inverter-driver stages V2 and V3 which, in turn, drive the push-pull output stage V8, V10, V12, and V13 (one-half), and V6, V7, V9, and V11 (the other half). Only the coupling between the phase-inverter-driver (V2 and V3) and the push-pull output stage employs coupling capacitors, the other stages being directly coupled. In addition to the main signal path just described, feedback paths are provided that, among other functions, determine whether the output from the Amplifier is constant voltage or constant current. Also included in the Amplifier (with all its options) are a metering circuit, overload indicator, and power supply. The basic function of each block is described in the following paragraphs.

4.2.4 Amplifier Circuit Description

a. Input Stages V1A and Q1: The source signal is applied to input stage V1A (half of a dual triode) through a voltage divider. V1 is directly coupled to Q1, which is connected in the emitter-follower configuration. The two stages together provide an impedance-changing function with extremely high input impedance

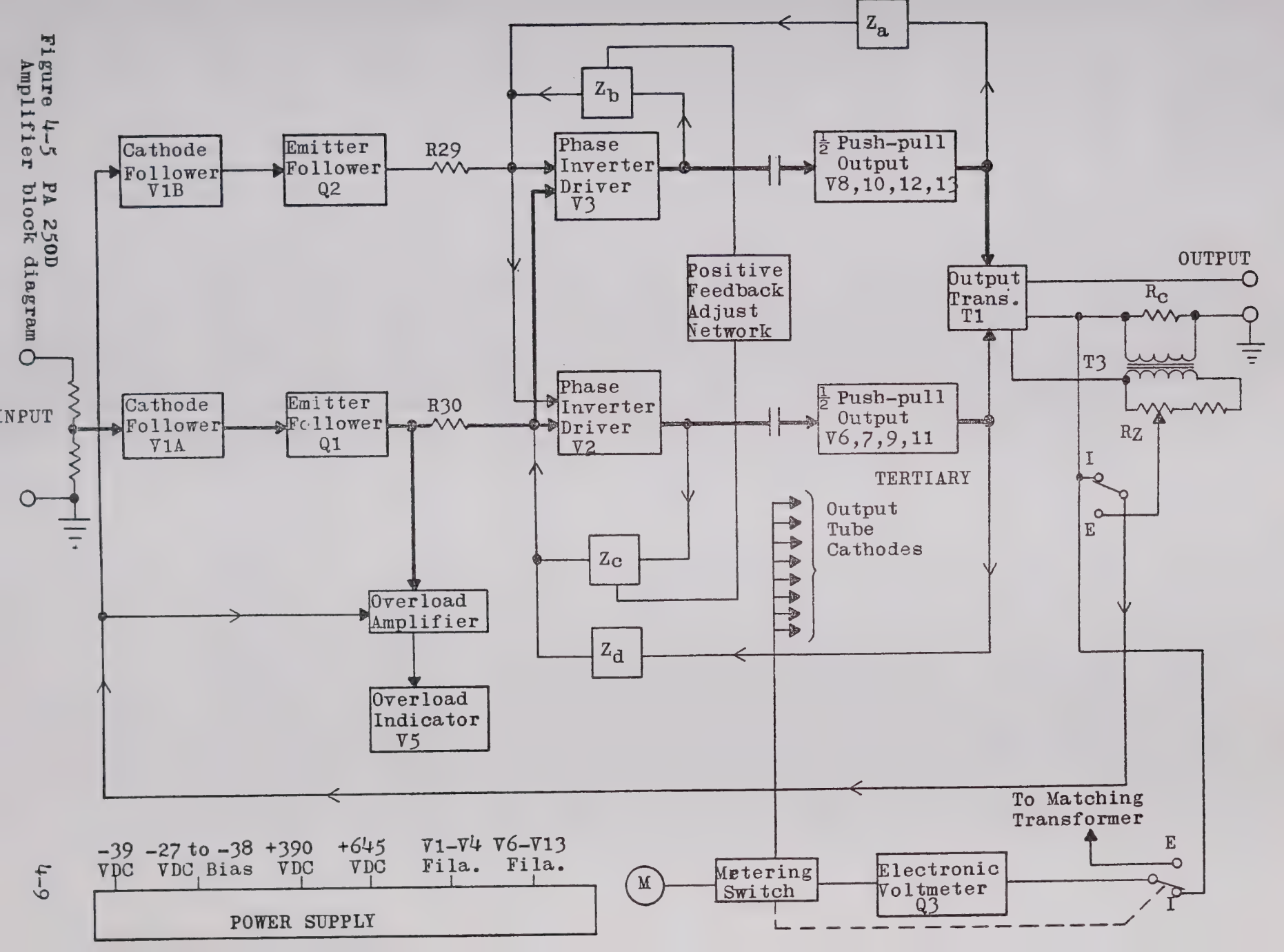


Figure 4-5 PA 250D Amplifier block diagram

and a low output impedance at the output of Q1. The low-impedance output of Q1 is applied through summing resistor R30 to both V2 and V3.

b. Cathode Follower V1B and Emitter-Follower Q2: A feedback signal (proportional to either output voltage or output current) is applied to the input of cathode follower V1B, and the output of V1B drives emitter-follower Q2. Like V1A and Q1, the V1B-Q2 combination also performs an impedance-changing function. Thus, it is seen that the combination V1B-Q2 functions for the feedback signal in a manner similar to the way the V1A-Q1 pair functions for the source signal. The output of Q2 is applied through summing resistor R29 to both V2 and V3.

c. Phase Inverter-Driver Stages V2 and V3: Phase inverter-driver stages V2 and V3 are each a triode-pentode in one envelope. For these stages and triode section is the input portion and is directly coupled to the pentode section. V2 is driven so no phase inversion of the source signal occurs but the feedback signal at the right side of R29 (summing point) does undergo a phase inversion. Conversely, V3 is driven so the source signal is inverted and the feedback signal at the right side of R30 (other summing point) does not undergo a phase inversion. Thus V2 and V3 provide the necessary out-of-phase signals to drive the push-pull output stage. In addition, V2 and V3 are arranged so the gain of each combination triode-pentode stage is very nearly equal to the amplification factor of the triode section of the tube. The result is that V2 and V3 each produces a large amount of gain (practically 100) and each has a relatively high input impedance and a low output impedance, thereby providing a suitable driving source for the push-pull output stage.

d. Output Stage: The push-pull signal from V2-V3 is capacitively coupled to the input of the push-pull output stage consisting of parallel-connected V6, V7, V9, and V11 in push-pull with parallel-connected V8, V10, V12, and V13. The outputs of these tubes are connected in a conventional manner to output transformer T1.

e. Feedback Loops: Several feedback loops are incorporated in the Amplifier. These were necessarily mentioned (intentionally only briefly) in the previous paragraphs and their functions will now be described in somewhat greater detail.

First, overall negative feedback voltage is provided by either the tertiary winding on T1 (constant-voltage mode) or by the drop across Current-sensing resistance in series with the output (constant-current mode). This overall negative feedback is applied as the input signal to V1B. The choice of constant-voltage or constant-current mode is made by switch S3 on the front

panel, and the source of overall negative feedback is also automatically changed simultaneously. In fact, it is the source of overall feedback that determines whether the Amplifier operates in the constant-voltage or constant-current mode.

Adjustment of the output regulation in the constant VOLTAGE mode is provided as follows:

> A phase inverting transformer T-3 is placed across the current sensing resistor to provide a source of positive feedback. A variable voltage divider R_z (front panel OUTPUT VOLTAGE REGulation adjustment) connected across T-3 output adjusts the amount of positive feedback added in series to the negative feedback - negative feedback being obtained from the output transformer T1 tertiary winding. This effectively allows adjustment of the internal output resistance (par. 3.4.1) to compensate for losses in the output transformers T1 secondary and losses in the Matching Transformer T-100R.
>
> The amount of positive feedback varies directly as the load, i.e. At no-load positive feedback is zero; there is no voltage drop across the output current sensing resistor R_c. As the load is applied a voltage is developed across R_c, which increases as the load is increased. This in turn provides an increasing amount of positive feedback added in series with the negative feedback. This reduces the overall negative feedback allowing the Amplifier output to increase thus compensating for the output voltage drop due to DC resistance of the output transformer secondary. Adjustment of R_z remains relatively constant from 100 to 1000 cps.
>
> The Amplifier basically has a zero internal output impedance. Therefore, with regard to the PA250D it is only necessary to compensate for the loss due to the D. C. resistance of T1 secondary. This is a relatively small amount of positive feedback. Sufficient positive feedback adjustment range is provided in the PA250D to compensate for losses in the output matching transformer T-100R.

Local positive feedback is applied (separately) around stages V2 and V3 to increase the open-loop gain and thereby increase the advantage (low

distortion and low output impedance) gained from the overall negative feedback. The amount of this positive feedback is controlled by the positive feedback adjusting network in conjunction with impedance Z_a, Z_b, and Z_c, (Z_a, Z_b, Z_c, and Z_d are all really R-C networks. Additional negative feedback is provided from the plates of the output tubes through Z_a and Z_d back to the summing points (right side of R29 and R30, respectively). This feedback compensates for the loss or reduction of overall feedback that would result with no load or the use of a relatively high-impedance load when the Amplifier is in the constant-current mode of operation. (Recall that in the constant-current mode, the amount of overall negative feedback is proportional to the current drawn by the load.) This additional negative feedback also provides the major portion of negative feedback above 100 kilocycles, thus preventing oscillations.

f. Electronic Voltmeter and METERING Switch S3: The electronic voltmeter amplifier stage (Q3) in conjunction with METERING switch S3 provides a rectified voltage for Meter M1. When the METERING switch is in the OUTPUT VOLTAGE or AMP. OUTPUT CURRENT position, a signal proportional respectively to the AC-101 output voltage or Amplifier output current is applied to the input of Q3. The signal is amplified by Q3, rectified by two diodes, and applied to Meter M1. Linear response of M1 is obtained by the connection of the diodes in the feedback loop of Q3. METERING switch S3 also has eight other positions to connect M1 to measure the cathode currents of the output tubes (V6 through V13) individually as a check for tube balance and aging.

The reason that the meter reads AMPlifier OUTPUT CURRENT and not the AC-101 output current (above 1KC) is as follows: The matching transformer T-100R itself starts drawing significant current above 1KC. For example, at 1KC this results in a meter reading 2% high; @ 10KC about 25% high; and 20 KC about 50% high for the AC-101 (these percentages assume full current output). Therefore the meter does not read true AC-101 output current above 1KC. It does however indicate true Amplifier output current.

g. Overload Circuit V4, V5: The overload indicator is arranged so a visual signal is given to the operator if the distortion becomes greater than approximately 1/4 percent at mid-frequencies. This is accomplished by applying a portion of the overall feedback signal (voltage - or current-derived) and a nominally equal amount of the source signal to V4 (a duo-triode) in such a way that the two signals tend to cancel each other. If the feedback signal contains frequency components that were not present in the source signal (i.e., distortion), this difference signal is amplified by V4 and applied to

V5, a self-indicating thyratron. The signal applied to V5 causes this tube to ionize and a glow appears in the overload indicator on the front panel.

h. Power Supply: The power supply provides two separate filament supplies, one completely balanced to ground, and DC voltages of regulated -39 volts, bias voltage of -27 to -38 volts, +368 volts, +390 volts, and +645 volts. Only solid-state semi-conductor rectifiers are used in the DC portions of the power supply. The bias voltage supply is arranged so that variations in screen voltage of the output tubes are accompanied by a corresponding change in the bias voltage, thereby tending to keep the output tube plate current constant. Thus, although no regulating circuits are used in the high-voltage supplies (plate and screen) for the output tubes, the stage is still amost completely free of the effects of line-voltage variations.

4.2.5 Miscellaneous AC-101 Data

a. Maximum Power Output: When operating directly from the PA250D Amplifier the maximum power output of the AC-101 is 250 watts. When operating through the T-100R Matching Transformer the maximum power out is 200 Watts. This maximum power output is limited to a line voltage of 117 VAC or greater, i.e., Max. Power, $P_a = 200 \frac{(E \text{ line})^2}{(117)^2}$. Therefore if the line voltage falls below 117V then the maximum available power is reduced in accordance with the above expression. As long as the maximum power utilized is equal to or less than P_a for a particular line voltage reduction, then the output is not effected.

b. Constant CURRENT Mode Distortion: At low frequencies distortion can be higher in the constant current mode through the Matching Transformer T-100R.

In the constant current mode the Amplifier looks like a high impedance source to the Transformer (T-100R). The magnetization current of the Transformer is non-linear. Its magnitude is inversely proportional to frequency. Therefore the distortion is higher at low frequencies due to the introduction of the non-linear parameters. This phenomena occurs primarily at frequencies below 100 cps.

c. Instantaneous Load Removal: Instantaneous removal of the load when operating in the constant CURRENT mode should not be done. DAMAGE TO THE AMPLIFIER MAY RESULT. The Amplifier is supplying a constant current to a finite load. The "load" impedance becomes infinite when the load is removed. The Amplifier tries to maintain a constant current

but cannot do so as the output voltage can only go to the "limit" of the Amplifier. From the expression E = IZ it can be seen that the output voltage would have to go to infinity to keep the current constant. This is aggravated with an inductive load due to the high voltage transient which will appear at the Amplifier output terminals from the collapsing field of the load (arcing).

Instantaneous removal of the load in the constant VOLTAGE mode will not damage the AC-101.

Section V

MAINTENANCE

5.1 CALIBRATION PROCEDURES

5.1.1 Frequency Calibration

Normally, the RCD Oscillators will operate for long periods of time without deterioration of frequency accuracy. To determine if the oscillator is within the ±1% specification, make the following checks:

1. Monitor the Output with a counter or frequency meter.

2. Set the VERNIER Frequency Control to the CALIBrate position (on earlier models without a CALIBrate position, set the knob with the slot vertical).

3. Check the frequency at 10, 100, 1000, and 10,000 cps utilizing the DECADE Frequency Range Selector. This test verifies the range-to-range tracking.

If the above frequencies are all within the specification of ±1%, the RCD is within calibration specification.

4. If each of the four ranges are within ±1% of each other but are all either higher or lower than 1% from the nominal frequency, the VERNIER Frequency Control needs to be re-indexed as follows:

   a) Set the VERNIER control so that the four frequencies of 10, 100, 1000 and 10,000 cps are within ±1% as indicated on the external frequency monitor.

   b) Loosen the set screws on the VERNIER Frequency Control knob taking care not to rotate the shaft.

   c) When the set screws are loosened, rotate the knob so that the slot is opposite the CALIBrate position.

d) Retighten the set screws.

e) Recheck the ranges to insure that the shaft has not moved during this procedure.

5. If the 4th decade (10,000 cps) is not within ±1%, it will be necessary to adjust Trimmer C1E which is located on the DECADE Frequency Range Selector switch deck located closest to the front panel. Adjust as follows:

a) Turn the DECADE Frequency Range Selector until the oscillator is set for 10,000 cps.

b) Adjust C1E for an output exactly of 10,000 cps.

NOTE: Be sure that the VERNIER Frequency Control is in the CALIBrate position when making this adjustment.

6. Check the tracking of the Frequency Selectors as follows:

a) Set the frequency at 1000 cps.

b) Check tracking of the most significant Frequency Selector by switching from 1000 to 9000 cps in 1000 cps steps.

c) Reset to 1000 cps and check the second Frequency Selector by switching from 1000 to 1900 cps in 100 cycle steps.

d) Check the tracking of the third Frequency Selector by switching from 1010 to 1090 cps in 10 cps steps.

This procedure outlined in No. 6 will check all resistors in the bridged-T frequency determining network. There are no adjustments for these resistors. If significant errors exist that put the unit out of specification, it is indicative of a malfunction in one of the switch wafers. Check to see that the switch contacts and wiper are free of foreign material.

5.1.2 Amplitude Calibration

To check amplitude flatness of the RCD-4 it is necessary to utilize an AC instrument with a frequency flatness of 0.1% or better from 10 to 10,000 cps. A transfer standard is a suitable device. When utilizing a transfer standard allowance must be made for the loading effect. The internal impedance of the oscillator is nominally 600 ohms.

A separate amplitude adjustment trimmer is provided for each frequency range. The trimmers for the 10,000, 1000, and 100 cps ranges are located on the glass epoxy board mounted vertically between the two rails. The trimmer for the 10 cycle range is located on the main printed circuit board. If the amplitude flatness is not within the specification of ±0.05 db it can be adjusted as follows:

1. Set the frequency to 10,000 cps.

2. Set the VERNIER Frequency Control to the CALIBrate position.

3. Set the output amplitude VERNIER and STEP control for maximum output.

4. Adjust R49 (located on the glass epoxy board) until the output is precisely 5 volts RMS. (Be sure to allow for the loading effect of a transfer standard if utilized and insure that any other type of AC instrument is accurate to ±0.1%).

5. Set the frequency to 1000 cps and adjust the trimmer R47 in a similar manner for precisely 5 volts output.

6. Set the output frequency to 100 cps and adjust R44 in a similar manner for precisely 5 volts output.

7. Set the output frequency to 10 cps and adjust the R17 located on the main printed circuit board in a similar manner to precisely 5 volts output.

Amplitude flatness has now been adjusted.

5.2 MAINTENANCE

The RCD Oscillators are designed and built under rigid quality control procedures that insure a minimum of downtime and maintenance. However, if difficulty is encountered, the following will help to isolate the problem.

5.2.1 DC BALance cannot be obtained. That is the DC BALance control is turned all the way to one end and still has not reached balance.

Cause.

Weak or defective V1, or transistors Q1 and/or Q2 may be defective.

5.2.2 Excessive distortion at 20 cycles.

Cause.

Zener diode CR3 is probably defective. Do not attempt to replace this diode with commercially obtained units. This part must be ordered from Optimation.

5.2.3 Excessive distortion. The distortion rises to approximately 0.05%.

Cause.

Probably caused by a defective transistor Q3. This will also cause a 10% loss of amplitude.

5.2.4 Very bad distortion or one-half of the waveform clipped.

Cause.

Probably defective transistors Q4 and/or Q5.

5.2.5 Excessive sensitivity to line voltage variation.

Cause.

This would be caused by a defective transistor Q8.

5.2.6 Either no voltage or 14 to 15 Volts from the power supply.

Cause.

This is caused by a defect in transistor Q7 and/or Q6.

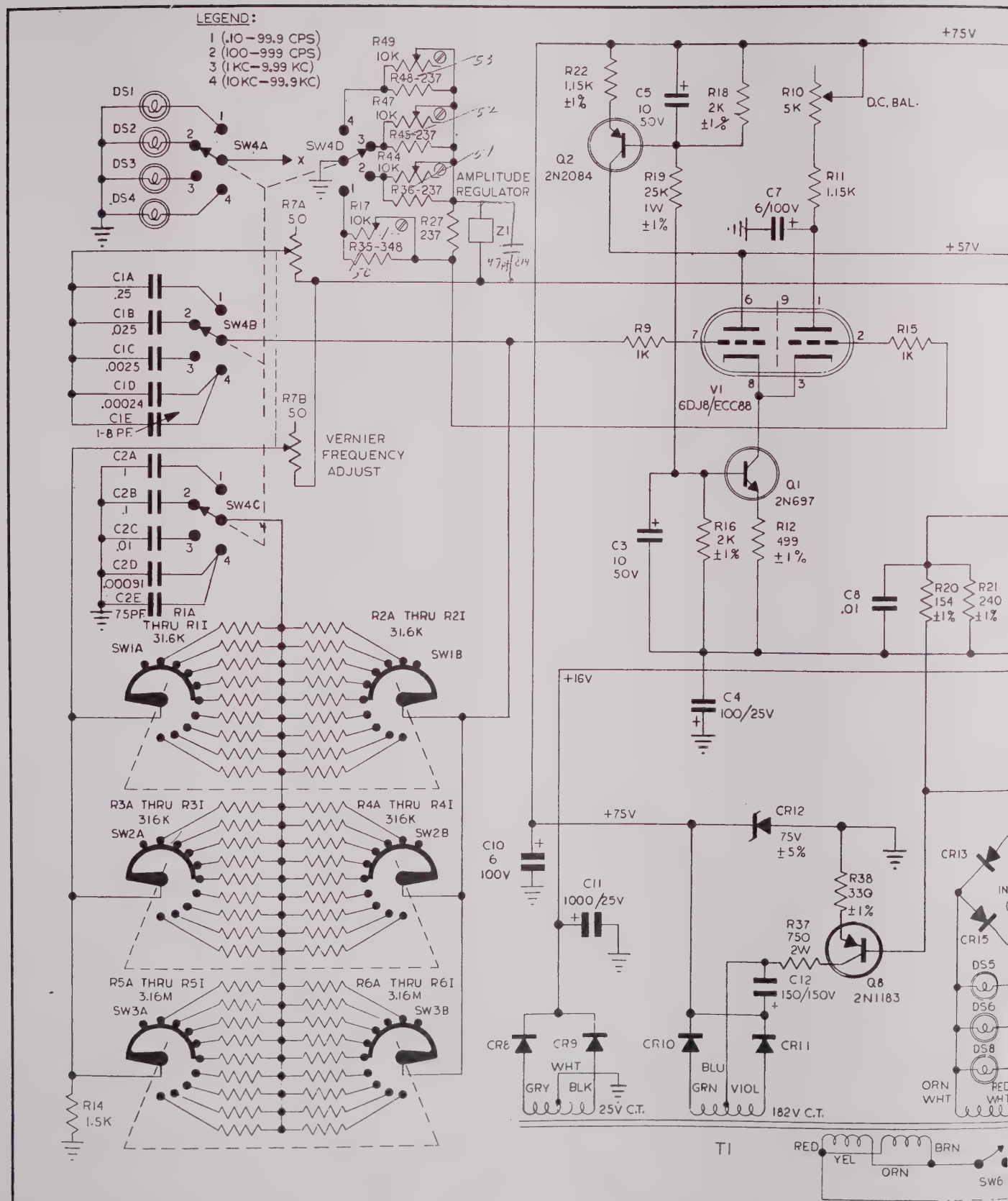
5.2.7 Power Supply voltages erroneous, -11 volt and +75 volt.

Cause.

This would be caused by defective Zener diode CR5.

WARRANTY

All Optimation, Inc. products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages. No other warrantys, expressed or implied, are contained herein.


LEGEND:
1 (.10—99.9 CPS)
2 (100—999 CPS)
3 (1 KC—9.99 KC)
4 (10KC—99.9KC)
DS1
DS2
DS3
DS4
SW4A
SW4D
R49 10K
R48-237
R47 10K
R45-237
R44 10K
R36-237
R17 10K
R35-348
R27 237
AMPLITUDE REGULATOR
Z1
R7A 50
C1A .25
C1B .025
C1C .0025
C1D .00024
C1E 1-8 PF
SW4B
R7B 50
VERNIER FREQUENCY ADJUST
C2A 1
C2B .1
C2C .01
C2D .00091
C2E 75PF
SW4C
R1A THRU R1I 31.6K
SW1A
R2A THRU R2I 31.6K
SW1B
R3A THRU R3I 316K
SW2A
R4A THRU R4I 316K
SW2B
R5A THRU R5I 3.16M
SW3A
R6A THRU R6I 3.16M
SW3B
R14 1.5K
+75V
R22 1.15K ±1%
C5 10 50V
R18 2K ±1%
R10 5K
D.C. BAL.
Q2 2N2084
R19 25K 1W ±1%
R11 1.15K
C7 6/100V
+57V
R9 1K
R15 1K
V1 6DJ8/ECC88
Q1 2N697
C3 10 50V
R16 2K ±1%
R12 499 ±1%
C8 .01
R20 154 ±1%
R21 240 ±1%
+16V
C4 100/25V
CR12
75V ±5%
C10 6 100V
C11 1000/25V
R38 330 ±1%
R37 750 2W
C12 150/150V
Q8 2N1183
CR8
CR9
CR10
CR11
WHT
GRY
BLK
BLU
GRN
VIOL
25V C.T.
182V C.T.
CR13
CR15
DS5
DS6
DS8
ORN
WHT
T1
RED
YEL
ORN
BRN
SW6

REVISIONS					
E.O.	SYM.	DESCRIPTION	DATE	CHK'D	APP'D
	A	REV. FOR SERIAL NO. 1016 & UP	3-13-3		
	B	CHANGED R34 FROM 2.5K TO 2K " R7A & R7B FROM 100Ω TO 50Ω " R14 FROM 2.5K TO 1.5K " BEGINNING SERIAL FROM 1027 TO 1051	9-4-63		

R28
1K

Q3
T1495

C9
500PF

CR3
56V
±5%

C6
6/100V

R24-47Ω

+16V

CR17
IN456A

R23
1K

R43-100Ω

Q4
2N697

CR4
8.2V
±5%

R48-470

Q5
2N697

R25
49.9
±1%

CR18
IN456A

ATTENUATOR

R34
2K

R29-604K

R30-6.04K

R31-60.4K

SW5B

VERNIER

R33
604K

R32
665K

OUTPUT

LEGEND:
1 (40db)
2 (20db)
3 (0db)

-11V

R43
56Ω-1W

X

R40
1.15K
±5%

R42
15
5W

CR7
IN456

V1

C13
3000

CR14

Q7
2N1306

CR5
6.8V
±5%

R41
2K
±1%

CR16

Q6
2N669

DS7

DS9

BRN
WHT
12.6V C.T.

F1
.2A

117VAC
50-400CPS

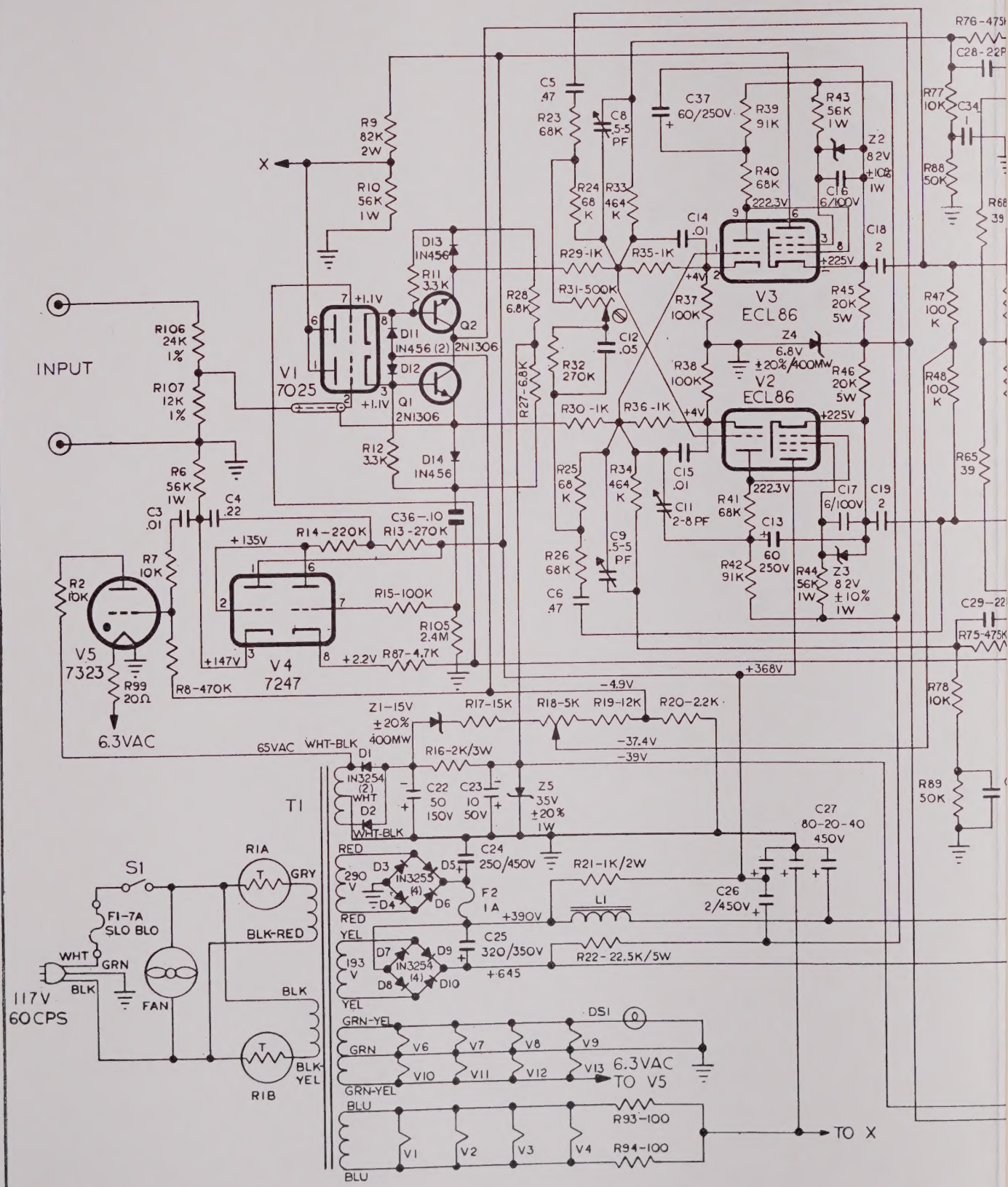
3. HIGHEST DESIGNATIONS USED: ~~R48~~ 53, C14, CR18, DS9, SW5, Q6 & V1.
2. DESIGNATIONS NOT USED: CR1, CR2, CR6, R13, ~~R19, R33, R39~~
1. ALL RESISTANCE VALUES IN OHMS & CAPACITANCE VALUES IN MFD.S UNLESS OTHERWISE SPECIFIED.

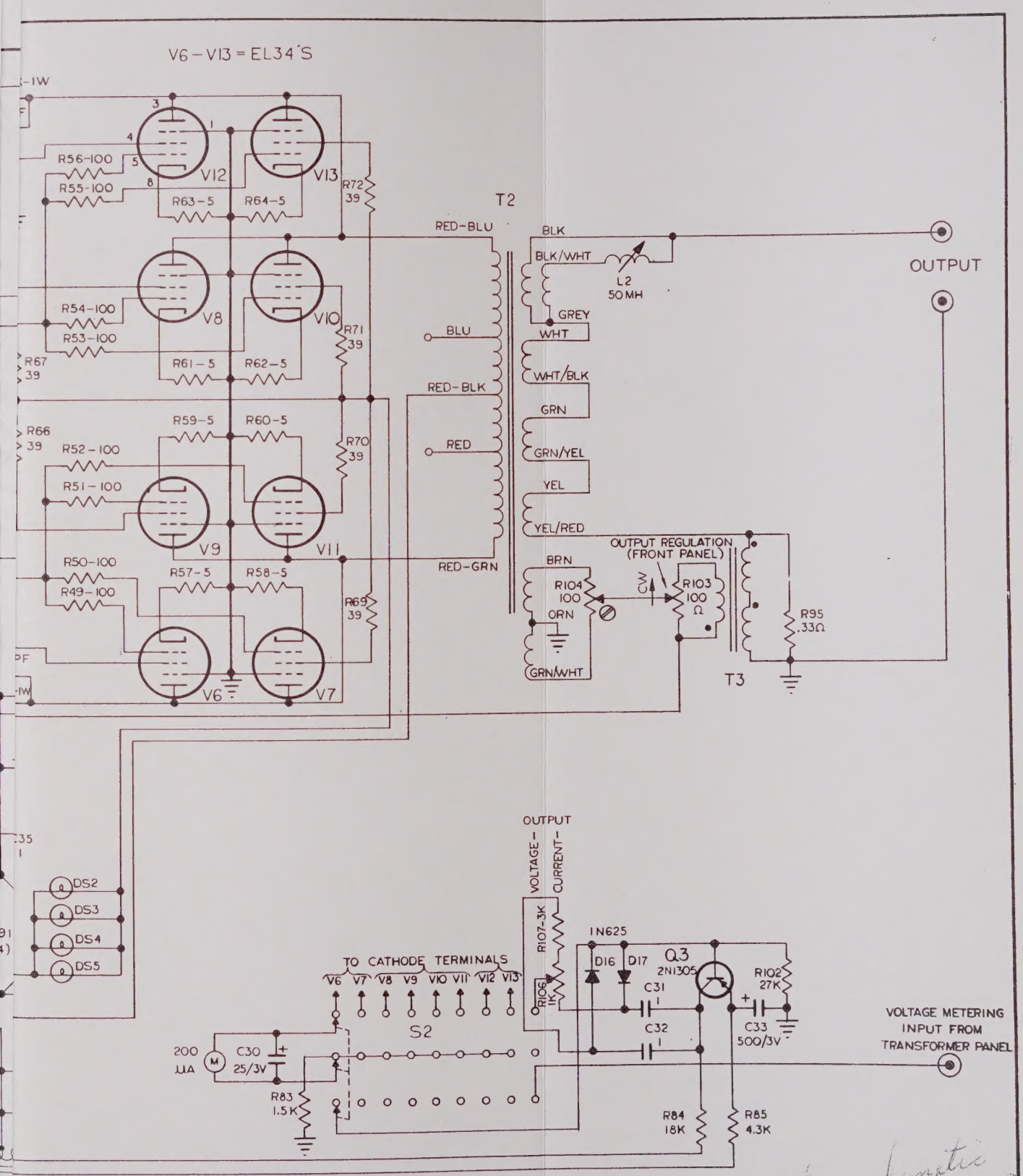
DASH NO	NEXT ASSEMBLY	NO REQ'D	FINAL ASSEMBLY	MODEL NUMBER	APPLICATION / DESCRIPTION	MAT'L	MAT'L SPEC	FIN
					MATERIALS			

TOLERANCES
UNLESS OTHERWISE SPEC'D DIMS ARE IN INCHES
FRACTIONS ±
DECIMALS .XX ± .010
ANGLES ± 1°
REMOVE ALL SHARP EDGES AND BURRS
MATERIAL
TREATMENT

DRAWN L. Rumsey	DATE 12-4-63	BASIC MODEL TITLE: OSCILLATOR
CHECKED	DATE	BASIC MODEL NUMBER: RCD4-B DRAWING NUMBER NO. 1051
APPROVED HDW	DATE 10-63	DRAWING TITLE: SCHEMATIC DIAGRAM, OSCILLATOR
REV. NO. 1	DATE 3-63	
DO NOT SCALE PRINT		
SCALE		

OPTIMATION INC.
LOS ANGELES, CALIF.
DRAWING NUMBER
004-D-509 B
SHEET 1 OF 1

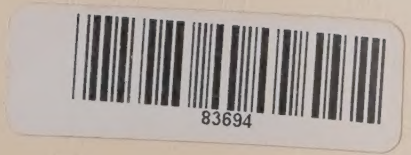

INPUT
V1 7025
V2 ECL86
V3 ECL86
V4 7247
V5 7323
Q1 2N1306
Q2 2N1306
D11 IN456 (2)
D12
D13 IN456
D14 IN456
R106 24K 1%
R107 12K 1%
R6 56K 1W
C3 .01
C4 .22
R7 10K
R2 10K
R8-470K
R99 20Ω
6.3VAC
R9 82K 2W
R10 56K 1W
X
R11 3.3K
R12 3.3K
R14-220K
R13-270K
C36-.10
+135V
+147V
+2.2V
R87-4.7K
R15-100K
R105 2.4M
R23 68K
C5 .47
C8 5-5 PF
R24 68 K
R33 464 K
R29-1K
R35-1K
R31-500K
C12 .05
R28 6.8K
R27-6.8K
R32 270K
R30-1K
R36-1K
C14 .01
C15 .01
C11 2-8 PF
R25 68 K
R34 464 K
C9 .5-5 PF
R26 68K
C6 .47
C37 60/250V
R39 91K
R40 68K
R37 100K
R38 100K
R41 68K
R42 91K
R43 56K 1W
Z2 82V ±10% 1W
C16 6/100V
C18 2
C17 6/100V
C19 2
C13 60 250V
R44 56K 1W
Z3 82V ±10% 1W
Z4 6.8V ±20% 400MW
R45 20K 5W
R46 20K 5W
R47 100 K
R48 100 K
R65 39
R68 39
R76-475K
C28-22P
R77 10K
C34 1
R88 50K
C29-22
R75-475K
R78 10K
R89 50K
+225V
+4V
222.3V
+368V
-4.9V
-37.4V
-39V
Z1-15V ±20% 400MW
R17-15K
R18-5K
R19-12K
R20-2.2K
65VAC
WHT-BLK
D1
D2
IN3254 (2)
WHT
WHT-BLK
R16-2K/3W
C22 50 150V
C23 10 50V
Z5 35V ±20% 1W
C24 250/450V
R21-1K/2W
C27 80-20-40 450V
C26 2/450V
L1
F2 1A
+390V
RED
290 V
D3
D4
D5
D6
IN3255 (4)
YEL
193 V
D7
D8
D9
D10
IN3254 (4)
C25 320/350V
R22-22.5K/5W
+645
T1
S1
F1-7A SLO BLO
WHT
GRN
BLK
117V 60CPS
FAN
R1A
R1B
GRY
BLK-RED
BLK
BLK-YEL
DS1
GRN-YEL
GRN
BLU
V6
V7
V8
V9
V10
V11
V12
V13
6.3VAC TO V5
R93-100
R94-100
V1
V2
V3
V4
TO X



3. L2 IS AN OPTIONAL PART.
2. ALL CAPACITOR VALUES IN MFD. AND RESISTORS IN OHMS
1. ALL RESISTORS ± 5%, 1/2W.
   R29, R30, R33, R34, R75, R76, R77, R78, R83, R88, AND R89 TO BE 1%,
   R2, R6, R7, R8, R13, R14, R15, R21, R37, R38, R47, R48, R49 - R56, R65 - R72,
   AND R87 TO BE 10%

NOTE: UNLESS OTHERWISE SPECIFIED

This schematic is similar to the 2502. Correct schematic will follow in a few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